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In and Above a London Fog.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

THE study of the upper air by means of kites and ballon-sondes has, during the last few years, not only increased our knowledge concerning the movements and physical conditions of this elevated region of our atmosphere, but revolutionised our ideas of what were assumed to be the existing state of things up aloft.

Physicists, astronomers, and others have, for instance, based numerous calculations on the assumption that a gradual decrease of temperature takes place as greater and greater heights are reached, and this decrease varies according to a certain law.

Recent researches have now shown us that even at quite comparatively speaking short distances from the earth's surface this law does not hold good, because "inversions" of temperature take place; that is, warm layers of air are found to flow over colder layers. Further, at heights of about 10 to 12 kilometres, the decrease of temperature ceases almost entirely, and so constant does this condition of affairs appear to be that this stratum has been termed the "isothermal" layer.

If one traces the curves of many of the records of temperature as registered during the flights of ballon-sondes it is found that after a height of about 12 kilometres the temperature actually begins to slowly rise until an altitude of about 24 or more kilometres has been attained. While kite flights and ballon-sondes journeys can be used to glean information of the very elevated strata of our atmosphere, manned balloons can do very useful work with regard to the study of those layers nearer the earth's surface.

During the last few years ballooning has become quite the fashion, and advantage should be taken of this fact to induce those who make ascents to glean and record as much meteorological information as they can secure on such trips.

To illustrate one phase of work that could be attempted is the object of the present article. Although in the pursuit of such information the conditions are not the most safe for an aërial voyage, yet the fact that ascents are commonly made when these conditions prevail suggests the value of utilising such occasions for this purpose.

The piece of work to which reference is made is the determination of the vertical extent of a fog which sometimes enwraps London. The horizontal distribution of the fog is known from ground observations, but the average height is at present an unknown quantity. Such journeys may be rendered more safe by obtaining beforehand useful information about the horizontal extent of the fog by telephoning to outlying districts and inqurinig about the prevailing conditions there. If the fog is purely local to London there seems little risk with regard to such voyages; should it, on the other hand, be of wide extent, then, perhaps, more caution ought to be taken.

Quite recently suggestions have again been made with regard to dispersing fog by some mechanical means or other, but surely the first step is to find out how high such fogs really are. So far as I can gather, this information, as I have said before, is entirely lacking.

If fog extended upwards three, or four, or five hundred feet, then, perhaps, numerous devices for dispersing it, if well distributed over the area enveloped, might possibly be commensurate with the amount of fog to be dispersed. But should such fogs be a thousand, two thousand, or even three thousand feet high, what mechanical means would be on a sufficiently large scale to make even an impression on such a vast mass of laden atmosphere?

Fig. 1.—The top of the fog as photographed at an altitude of 3000 ft. above Bexley Heath.

It was my good fortune on October 27 of last year, thanks to the kindness of the Honourable Mrs. Assheton Harbord, to make an ascent from Battersea on a day when London was covered with a fog. The fog was not very dense on the ground, but yet sufficiently thick to obliterate objects one hundred yards distant. There was very little movement of the air, and what current there was was blowing from the west. The complement of the basket of the "Valkyrie" (60,000 cubic feet capacity) on that occasion was the Honourable Mrs. Harbord, who is the owner of the balloon, Mr. C. F. Pollock, Mr. J. Dunville, Captain C. de Crespigny, and myself.

At the order "Hands off," at 12h. 3m. p.m., we slowly ascended and shaped an eastward course. Owing to the thickness of the fog a low altitude was maintained to determine the direction of travel of the balloon. During the first half-hour the maximum

height attained was 1,300 feet, but still we were in the fog. A dip down to earth to find out about our whereabouts by questioning people (it was too thick to recognise objects and determine our position from the Ordnance map) showed that the fog was still fairly thick there. After an hour and twenty minutes from the start we were at an altitude of 2,200, but still enshrouded in mist. Above us we could see the sun struggling to penetrate the fog, but without success.

Our course so far had been over Camberwell, Lewisham, Blackheath, and Shooters Hill, and an approach was made to the earth near Bexley to make inquiries. An ascent was next made for lunch, and it was decided to get out of the fog for this purpose. At a *height of 2,500 feet we just topped the fog*, and we maintained an elevation of 3,100 during lunch-time.

The sea of cloud below and around one presented a magnificent scene. The fog we had traversed was a veritable cumulus cloud 2,500 feet thick, resting on the earth and extending away in every direction of the com-

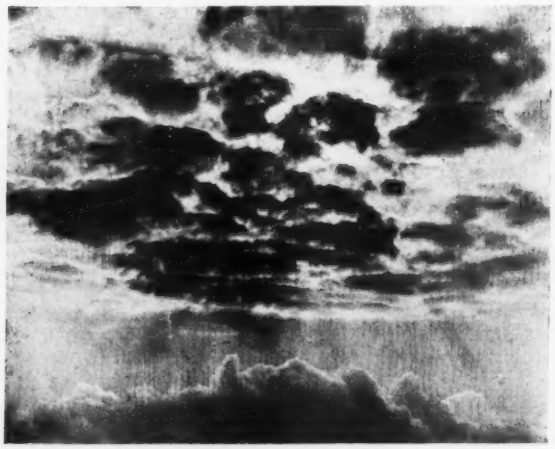

Fig. 2.—At [an altitude of 4,800 ft. above Gravesend. The fog below and alto-Cumulus cloud above.

pass. The billowy nature of its upper portion will be seen from Fig. 1, which was taken by me at an altitude of 3,000 feet above Bexley Heath.

After a plunge into the fog and descent to earth at North Fleet for inquiries, and another rise to a height of 4,800 feet into the sunshine, we were placed again between the fog below and the alto-cumulus above. The rays of sunshine lighting up the billowy cloud-tops below formed a striking sight, only a portion of the beauty of which can be gathered from the accompanying reproduction (Fig. 2). This photograph was taken at our maximum elevation of 4,800 feet.

The final descent was made to the east of Gravesend at Higham (Kent) at 3h. 5m. p.m., the fog being thicker on the ground there than it was at the ascent. We had thus covered twenty-six miles in about three hours, or had travelled at the rate of about eight-and-a-half miles an hour. From inquiries made since it was found that the fog on this day was very widely distributed over the country, reaching even Brighton and the Channel.

It would be interesting, therefore, to make an ascent when it is known that a dense fog prevails in London, while the country is comparatively clear. One would then be able to gauge its capacity, which might help to throw some light on its origin and mode of formation.

Ions.

By R. G. DURRANT.

PART II.

Continued from page 208.

For the benefit of "non-experts," I shall therefore attempt a pictorial account of what would happen if two rods of carbon, being the terminals of a battery, were dipped into salt water. I shall look on ions as boats and on electrons as individuals, because my readers, whether experts or no, are acquainted with boats and are interested in individuals. But I must guard myself when I launch out into metaphor by stating that no metaphor is ever perfect, and further by stating that while boats and individuals are "things that you may touch or see," ions and electrons are only felt when they move in crowds, and are only to be seen in the mind's eye.

Let us then suppose the two carbon rods, connected by stout wires to a battery, are dipped into salt water. The tendency of the electrons will be to move in a direction the reverse of that usually described as "the direction of a current," they will move into the water from the "negative" carbon pole. Before leaving this "port of departure," each electron must find a suitable boat bound for the "port of arrival." These boats may be said to belong to the "Chlorine and Hydroxyl Company" (limited but numerous), and it will be seen in the sequel that the Company's "building yard" for hydroxyl boats is close at hand. The electrons dash into the nearest boats and there is only one vacant place in each boat. Many electrons are "upset" at once, but when this occurs substitutes instantly take their places, and in any case it would seem that the departure of each boat is brought about by the impetus of the electron who first dashed in, and, since millions dash in every second, hydroxidion and chlorion boats are constantly moving "out of port," the former with an average speed of nearly three times that of the latter. But the space from "port to port" is so crowded with boats that those first impelled by the electrons bump against boats in front, and these again bump other boats further in front, and so it happens that the very first dash of electrons at the "port of departure" sends a shock to the "port of arrival," with a result which we shall consider very soon. It is important to remember that nearly all the boats in this metaphor are "submarines."

It would take too long to follow the fortunes of any one boat. The electron who first got in does not necessarily reach his ideal destination, for there is an enormous amount of "mid-ocean" exchange of passengers and this particular electron may return after a short cruise in one of the rival company's boats, as a mere slave in the "hull," or he may get stranded in a molecule of water, which amounts to being drowned for the time being. But whatever happens to the individual, that dash of his into his boat made itself felt so that another electron, just waiting to "land," sprang out at the very moment our friend dashed in.

The general interest, therefore, is directed to the "landing stage." Here electrons are springing out of their "chlorion" and "hydroxidion" boats with just as much dash as did their "free brothers" when they sprang in. These "landed" electrons rush up the

"gangway" and disappear into the cells where those forces which launched their "brothers" are still at work. And if my reader asks how it is that the "dashing in" at one port *instantly* causes a dashing out of boats at the other port, the answer lies in the fact that besides water and "boats" and electrons, the whole space is permeated by that subtle but responsive thing called "æther." But what happens to these "boats" when the electrons are "landed"? Evidently there must be a recoil, but this is not all, for the chlorions collide in pairs, now that the electrons have disembarked, and change into a yellow gas with a strong smell which dissolves in the water close by. Slowly, however, the chlorine gas reacts with the water and this reaction is hastened by the "actinic" rays of the sun with the result that another gas, oxygen, is produced together with two fresh ions, namely, a new chlorion with its electron rescued by the sun from the water, and a hydrion, which may be considered to owe its empty berth to the electron which is likely to land in the new chlorion. It is the hydrion, however, that responds to the recoil shock, and starts on the return journey as a fast boat—the fastest known. Before we follow the hydrion we have to learn what befell the hydroxidions when their electron passengers escaped. These boats also were "kicked back," collided, and joined up partly in pairs to form a substance called hydrogen peroxide, but more frequently in quartettes to form oxygen gas and ordinary molecules of water. Hence it would seem that the only return-journey boats produced at the landing stage are the rapid hydrions, and that these must be fewer in number than the combined chlorions and hydroxidions which were destroyed as such when the electrons landed. But to supply this deficiency there are the sodions ready waiting. These are not specially manufactured "in dock," but are instantly produced together with an equal number of chlorions when common salt is dissolved in water.

This change is represented thus:—

$$\text{I.}\quad \underset{\text{Sodium chloride.}}{NaCl} = \underset{\text{Sodion and chlorion.}}{Na^{\cdot} + Cl'}$$

The discharge of electrons from chlorions thus:—

$$\text{II.}\quad \underset{\text{Two chlorions.}}{Cl' + Cl'} = \underset{\text{Chlorine gas and 2 electrons.}}{Cl_2 + ''}$$

The sun's action on chlorine and water thus:—

$$\text{III.}\quad \underset{\text{Two molecules of chlorine gas}}{2\,Cl_2} + \underset{\text{2 molecules of water}}{2\,H_2O} = \underset{\text{4 chlorions, 4 hydrions and oxygen gas.}}{4\,Cl' + 4\,H^{\cdot} + O_2}$$

The discharge of electrons from the hydroxidions thus:—

$$\text{IV}(a).\quad \underset{\text{Two hydroxidions.}}{2\,(OH)'} = \underset{\text{Hydrogen peroxide and 2 electrons.}}{H_2O_2 + ''}$$

also

$$\text{IV}(b).\quad \underset{\text{Four hydroxidions.}}{4\,(OH)'} = \underset{\text{Water.}}{2\,H_2O} + \underset{\text{Oxygen and 4 electrons.}}{O_2 + ''''}$$

These freed electrons are symbolised by dashes, and this symbol, in connection with the metaphor employed, seems to be appropriate.

We must now consider the "Hydrion and Sodion Company's" "boats." The hydrions are believed to contain about eight hundred electrons, and the sodions twenty-three times as many, but all these electrons are occupied in maintaining the structure of their own vessels, and how this is done we do not know. There is, however, an "empty berth" in each vessel, room for one more electron, and the recoil each vessel received at the landing stage urges it in the right direction to get that berth filled; that is to say, they move toward the "port of departure" and the pulse from each recoil is instantly felt at the ideal destination.

Therefore we leave the actual boats to their fates, return to the starting point, and watch the substitutes come in. Threading their way through the outward bound boats, the hydrions make for the electrons streaming down the gangway. Many hydrions are destroyed by collisions, especially with the out-going hydroxidions ($H^{\cdot} + OH' = H_2O$), but others reach the stream of "leaping" electrons. Each hydrion takes in one electron, then two hydrions with their extra inmates join together, linger on the carbon pole until other pairs have formed small bubbles with them, and then rise into the air with their captives.

Thus we see that many electrons at the very start are destined for a journey in the air and never get the chance of moving in the salt water.

The change is symbolised thus:—

$$\text{V.}\quad \underset{\text{Two hydrions and 2 electrons.}}{H^{\cdot} + H^{\cdot} + ''} = \underset{\text{Hydrogen molecule.}}{H_2}$$

The sodions also come in to meet the outward-bound electrons. Each sodion takes one electron to fill the empty berth, then the completed atoms join and instantly react with water to produce three things, namely, hydroxidions, fresh sodions, and more hydrogen. These newly-manufactured hydroxidions are ready to start on the outward journey—the fresh sodions are likely to charge in once more and to repeat the performances just mentioned, while the hydrogen gas, which is produced from the water, rises with the other hydrogen which had captured electrons.

The action of the electrons on the sodions is symbolised thus:—

$$\text{VI.}\quad \underset{\text{Two sodions and 2 electrons.}}{Na^{\cdot} + Na^{\cdot} + ''} = \underset{\text{Sodium molecule.}}{Na_2}$$

The subsequent action of sodium on water is symbolised thus:—

$$\text{VII.}\quad \underset{\text{Sodium and water.}}{Na_2 + 2\,H_2O} = \underset{\text{Two sodions, 2 hydroxidions and hydrogen.}}{Na^{\cdot} + Na^{\cdot} + OH' + OH' + H_2}$$

which appears to show that the two electrons in (VI.) are started on their outward journey in the two hydroxidions produced in (VII.), but the chances are very much against these being the identical electrons which filled the sodion berths. It must be remembered that other electrons get started in chlorion boats, but these boats, unlike the hydroxidions, are not specially manufactured on the spot (equation No. I. shows their formation).

This metaphorical account can only pretend to give a general notion as to how a current passes through salt water, and it would be outside the province of an article like this to particularise too minutely; nevertheless, some idea as to actual speed of ions and number of electrons may be of interest. With this idea in view an actual experiment was performed, in which a salt-water jelly was prepared in a tube tinted with purple litmus, the bent ends of the tube dipped into

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glasses containing very salt water and into these glasses the two carbon poles, joined to the terminal of fifteen storage cells, were respectively fixed. In technical language, the electro-motive force was thirty volts, and the "potential gradient" rather less than one volt per centimeter (since the tube was thirty-six centimeters long) while the current passing was only about the fortieth part of one "ampère."

Before describing what happened in this tube I shall ask my reader to consider the tube as a railway laid out with a considerable number of parallel lines, and these main-lines frequently connected by shorter slanting lines. At either end there is a station, and on all the lines there are a great number of disconnected trucks. The most easily moved trucks are hydrions, then hydroxidions, which naturally move half as fast, then a still larger number of much slower trucks, chlorions and sodions, which move respectively at one-sixth and one-seventh of the hydrion speed. In this new metaphor electrons are represented as small rapid engines, which dash up against the trucks from beyond the up-station, but the only trucks they can force forward are hydroxidions and chlorions, because the wheels of the other trucks are arranged with brakes to resist a down-line direction. From beyond the down-station "recoil-engines" act exactly like the electrons and these recoil-engines can only force hydrions and sodions to move up-line because of the resisting brakes on down-line trucks. The effect produced by the bombarding engines from each station will be to get their faster trucks gradually on to the main parallel lines, the down-lines will get cleared for hydroxidions and the up-lines for the hydrions, the other trucks will frequently be shunted on to the connecting lines.

Now I will return to the actual experiment, and I must at once state that purple litmus keeps purple as long as hydrions and hydroxidions are locally in equal numerical proportions, if hydrions are knocked away it becomes blue, if hydroxidions are knocked away it becomes red, and further, if for any reason chlorions get locally congregated the litmus becomes colourless in that locality, while congregations of sodions produce a blue colour. Soon after the battery had been connected up, bubbles of oxygen were observed at the anode, corresponding to the *down*-station in this metaphor, but no hydrogen appeared at the kathode or up-station. A water voltameter was thrown into the circuit to gauge the value of the current, and in this voltameter hydrogen was produced and measured.

To explain this *non*-appearance of hydrogen from the salt solution, I refer my reader to the previous account given of the hydrions striving to reach the "port of departure," and being "upset" by the out-going hydroxidions ($H^{\cdot} + OH' = H_2O$). After some hours, however, hydrogen began to appear because the steady inflow of hydrions is twice as rapid as the steady outflow of hydroxidions from this "port of departure" or "up-station." This appearance of hydrogen at the kathode was accompanied by a more rapid movement of blue colour down the tube; for previously the blue had only penetrated a very little way, while from the other end red had started, but moved at a still more sluggish rate.

After 18 hours the front of the blue now "in the straight" was measured, and three hours later it had advanced 2.4 centimeters (rather less than an inch). In the next three hours it moved exactly three centimeters, in the next three hours 3.15 centimeters, and in the next 3.55 centimeters, and it was then only one centimeter from the front of the red. The red advance had been measured during the last three intervals and had kept going half as fast as the blue. The meeting place of the red and blue (both sharply defined) was almost exactly at a point two-thirds down the tube. Thus two-thirds of the tube was now blue, because the hydrions had moved to the kathode and had left the litmus blue, while the hydroxidions had left the litmus behind them, red for one-third of the tube, since they had moved half as fast toward the anode.

It will be seen that the effects of the ions were manifested at the end of their movements and not at the start (the *end* trucks are the first to get free motion). After the clash of the colours (red and blue), the question was, what would happen next, for this two-third distance represented, so to speak, the place where the "shunting shocks" up-line and down-line crossed each other.

The experiment showed a steady advance of blue swallowing up the red, but for the first 10 hours the average speed was reduced to one-fifth of what it had previously attained, and for the next 3 hours it was found to be about one-third; thus a considerable check to speed of the blue was introduced, but this check was being overcome by the constant on-flow of the hydrions. Two other rather striking things were observed, one was the appearance of a sharp deep blue line about 1 millimeter thick, which remained fixed for thirteen hours at the point where the meeting of red and blue took place; five minutes later this line suddenly shifted through four millimeters towards the anode. The other thing was a completely colourless band in the blue litmus, extending exactly half a centimeter from the sharp blue line, and extending also toward the anode; its length was one-seventh of that of the advanced blue when measured after thirteen hours.

This colourless band represented the advance of the sodions during that period. Sodions are known to move naturally at one-seventh of the speed of the hydrions; and just as the hydrions' motion was evidenced by their *leaving* hydroxidions to turn the litmus blue, so here the sodions' motion was evidenced by their *leaving* chlorions to bleach the litmus. The battery was disconnected when the tube was blue from end to end, for the local bleaching was subsequently swallowed up by the blue. The sudden movement of the sharp blue line was interesting because it showed a local accumulation of charge, and the movement, like that of charged clouds, often takes place against the wind, for the main "breeze" in this tube was along the hydrions' path and the band shunted backward into the charged chlorion region; probably the band itself was due to sodions balanced for a time between opposing forces.

So much for the ions. As regards the number of electrons in this experiment, there would be about a quarter of a trillion every second acting at the originally blue end of the tube, while the same number emerged every second, with recoil action, at the other end. In this experiment the constant hail of electrons, one trillion in four seconds, and lasting for more than two days, could only make the very fastest ions clear their way through the crowded thoroughfare, and the thoroughfare was only fifteen inches long!

XUM

The Spectrum of Comet 1907d. (Daniel).

IN a recently issued *Lick Observatory Bulletin*, No. 135, Director W. W. Campbell discusses the reduction of a series of photographs of the spectrum of Daniel's comet of 1907, obtained on various mornings between July 14 and September 8 with the 36-inch refractor.

Preliminary visual observations on July 14 showed the presence of the carbon bands at λλ 4737, 5165, and 5635, the continuous spectrum of the nucleus and coma being also strong. By August 9 the character of the visual spectrum had altered considerably. The

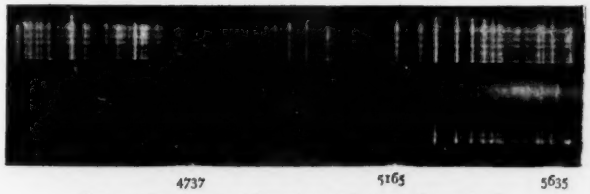


Fig. 1.—Spectrum of Comet 1907d.-1907, August 16.

continuous spectrum of the nucleus remained strong, but that of the coma was much fainter, rendering the carbon bands more conspicuous, and enabling two or three maxima to be seen in the head of the band at λ 5165. These bands appeared to cross the nucleus without perceptible strengthening, and could be followed out into the tail for about 1°. Towards the end of August, as the comet approached perihelion, the bright bands apparently increased in intensity.

Photographic exposures for the spectrum were made on nine occasions, one of 2 hours with the Mills spectrograph in the hope of recording the bright blue band with sufficient dispersion to obtain accurate wave-

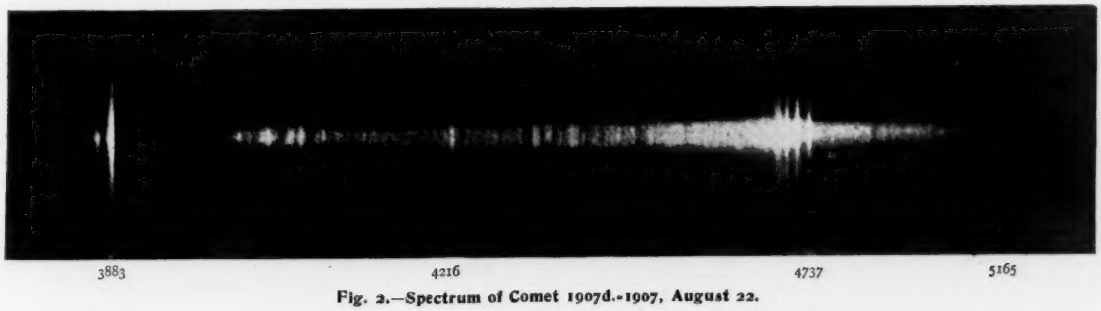


Fig. 2.—Spectrum of Comet 1907d.-1907, August 22.

lengths, but this was not successful. Five of the others were good, and two of them are here reproduced. That shown in Fig. 1 was taken on an isochromatic plate, giving greater extension into the yellow, and shows the iron comparison spectrum on either side of the spectrum of the comet. For the determination of wave-lengths the bright lines at λλ 3871.5, 4737.2 and 5165.3 were assumed correct and also the dark lines at λλ 4101.89 ($H\delta$), and 4383.72 (Fe). In the table accompanying the paper 61 bright lines are catalogued, with intercomparisons showing results obtained from other comets and laboratory spectra of carbon, etc.

From a careful analysis of the results and close inspection of the relative structure of the bands on the photographs, there appears to be no doubt that the 2nd, 3rd, 4th, and 5th bands of the arc spectrum of carbon, and the 2nd and 3rd bands of cyanogen are represented in the comet spectrum, corresponding very nearly to the whole of the comet's bright-line radiation in the photographic region. There are no identifications of other elements or compounds, not even a trace of hydrogen. The spectrum of cyanogen from a Plücker tube gives a number of strong bands, but the arrangement is not that of the comet spectrum. In the spark spectrum of carbon, after eliminating the iron lines occurring as impurities nearly all the light falls in the 3rd cyanogen band at λ 3884, the 2nd band being much fainter. It will be seen that the band extending from λ 3884-3872, produced by the carbon spark and the C.N. vacuum tube, does not wholly represent the relative intensities of the comet band, and the comet structure was nearly reproduced in the hydrogen tube containing cyanogen used by Wright for comparisons of the comet 1899a.

The continuous and dark line spectra are best seen in the spectrum of August 22 (see Fig. 2). For that photograph the slit was adjusted so that it extended far on either side of the comet's nucleus, and there is thus no possibility that the sky spectrum at dawn exerted any influence on the result. So far as can be seen these spectra appear to be identical with the solar Fraunhofer spectrum if allowance is made for the superimposed bright lines, but Professor Campbell thinks there may be an indication of the maximum of continuous spectrum being displaced towards the red. The long bright lines cross the spectrum of the nucleus with little intensification, as if they were due solely to coma radiations, the nucleus contributing to them but feebly. Many of the short bright lines, however, seem not to extend beyond the nucleus, though in many cases this may be due to their faintness. It would appear that the nucleus is shining chiefly by virtue of sunlight reflected from the materials composing it, while the coma is evidently shining very largely by inherent light. The spectroscopic observations of the tail seem to show that the inherent light, existing in large proportions near the head, decreases in proportion to reflected or diffused sunlight with increasing distance from the head. Independent observations by Messrs. Duncan and Campbell showed slight polarisation effects in the parts of the tail near the head and in the coma, prior to August 14, but none after that date; none were observed at any time in the light of the nucleus. The proportion of inherent to foreign light evidently increased so that by August 14 the comet's own variations were strong enough to mask any polarization produced in diffused sunlight by the coma and tail.

XUM

Flint Saws and their Various Forms.

By ALEXANDER J. HOGG.

ON visiting Cissbury, or one of the sites of the many other factories of flint implements which flourished in localities where the outcrop of the chalk formation made the raw material easy of access, we see before us, covering perhaps many acres, the abundant rubbish which the ancient workers have left spread over the surface.

This refuse consists not only of the spalls or chips detached in the first instance from nodules or nuclei of flint, and the rejected cores of the nuclei themselves, but also of wasters, or abortive attempts at making various classes of implements, which from imperfections in the material, or from want of skill on the part of the workman, have resulted in failure.

These failures, however, manifest evidence of design, and the imperfect weapon, or the tool arrested in development, sufficiently show the intention of the workman; although the great variety of the types, and the imperfections of the individual specimens may cause some difficulty in their recognition.

Such is also the case on sites of palæolithic or neolithic stations which have been occupied intermittently by different tribes or races, and where the variations of form or of workmanship proper to each have resulted in an assemblage from which it is difficult to discriminate, without a certain degree of familiarity with the typical forms. The tools of the Bronze and Iron Ages also passed through many modifications before reaching the forms by which they are now represented; and the influence of the ancestral precursor can frequently be recognised.

These considerations show the importance of establishing a series of types of each tool or weapon, before attempting to fix a chronological sequence; and by this means only can the evolution of each be traced from its first appearance, and the continuity of form from period to period be demonstrated.

In his admirable Guide to the Antiquities of the Bronze Age, Mr. C. H. Read states that "the attempt to assign absolute dates to objects earlier than any historical records, is based upon the previous establishment of a *relative* chronology, obtained through a classification by sequence of types."*

The system so successfully adopted by Mr. Read is also the only one by which we can arrive at a scientific arrangement of the yet earlier remains of the Stone Age. Some remarks by Dr. Munro on this point are so much to the purpose that I cannot refrain from quoting them. He says of primitive man that, "by means of his special monopoly as a tool maker, he manufactured a variety of implements, weapons, and tools, by the use of which he established a supremacy over all other animals. These inventions, being virtually the products of an intelligent mind, have one important characteristic, which is of inestimable value in the study of archæology, viz., they disclose the technical skill, and teleological purpose of their manufacturers. . . . In the selection of material for the manufacture of tools, as well as in the methods and contrivances by which they are adjusted, it must be acknowledged that prehistoric man exercised an almost faultless judgment, as they invariably disclose a pre-eminent fitness for the special purpose for which they were intended."*

Fully agreeing with the views of this eminent authority, I would venture to add that there are many tools for which our imperfect knowledge will not enable us to suggest any specific use; but which nevertheless continued to be necessary to man through long ages, and in different parts of the world; and it is these especially which have hitherto escaped notice, but should yet be recorded. At some future time a closer investigation into the habits of existing savage tribes than has so far been made will probably throw fresh light on the subject. Various forms of the saw have, however, been recognised, and it is the object of this paper to add to the number, by illustrating some of the types most frequently to be met with in this country. It would be well, perhaps, to anticipate enquiry by stating here how these types have been arrived at.

Some thirty years since, on visiting the National collection, I was struck by the scarcity of objects that could be described as *tools;* and considering that the condition of man at successive epochs might best be elucidated by a comparison of the implements in use at each period, I began to form a collection of worked flints, both from the surface and from gravels, which soon numbered thousands.

These were arranged in groups showing a general similarity; from these all forms occurring in duplicate were laid aside, and on the appearance of a third, a preliminary type was constituted. This was afterwards intensified by selection of examples exhibiting the special characters of each in the highest degree; and finally a rough generalised sketch preserved the types for reference when required.

In this way the following forms of the saw have been evolved, in addition to about forty distinctly typical tools of other kinds; exclusive of the axes, hammers, etc., the shapes of which are generally known.

The saw is an implement possessing a character by which it can easily be recognised—its cutting edge is divided by a series of notches, thus forming a row of teeth on one plane, by which it is distinguished from the knife, whose edge is simple and continuous.

The saw makes an incision by working backwards and forwards along a given line; the knife cuts in one direction only. Knives were also made in definite patterns, and form a separate series, irrespective of the simple keen-edged flakes, which when notched served as saws.

Dr. Munro says: "In the earlier archæological works the term saw is indiscriminately applied to a knife-flake accidentally chipped by usage, as well as to one intentionally trimmed."†

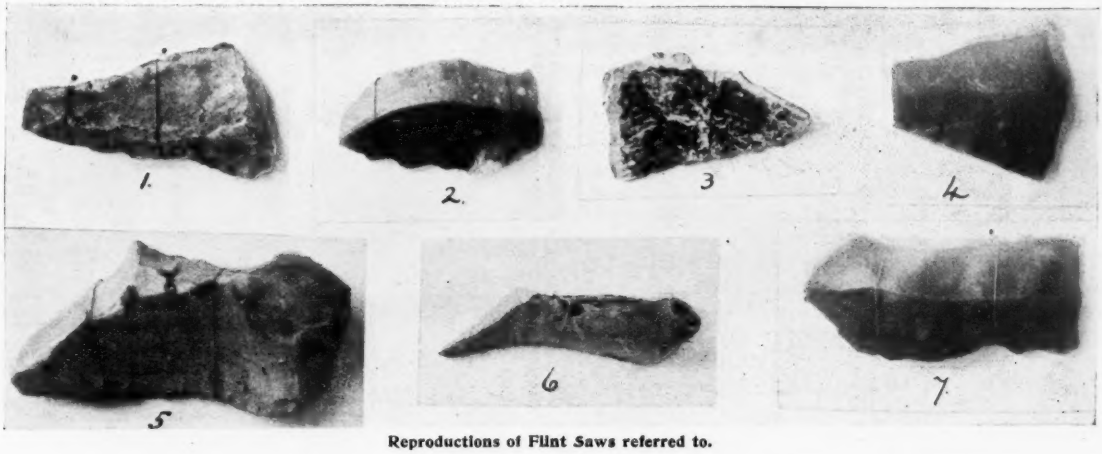
The confusion between the two implements has been further increased by the number of cases in which a knife blunted by use has been transformed into a saw, by chipping teeth from alternate sides; thus forming the sinuous edge, which is reproduced in the modern iron saws, by bending the teeth alternately in opposite directions, and serves the purpose of keeping the cut clear, by withdrawing the saw-dust at every backward and forward motion of the instrument.

* "Antiquities of the Bronze Age in the British Museum," p. 25.

* "Prehistoric Scotland," by Robt. Munro, M.D., pp. 137-139.

† "Prehistoric Scotland," p. 164.

The following illustrations, all half the size of the originals, are intended to assist in the identification of some of the more typical forms of this tool. The numbers do not indicate any chronological arrangement; the first object to be aimed at being the establishment of the types.

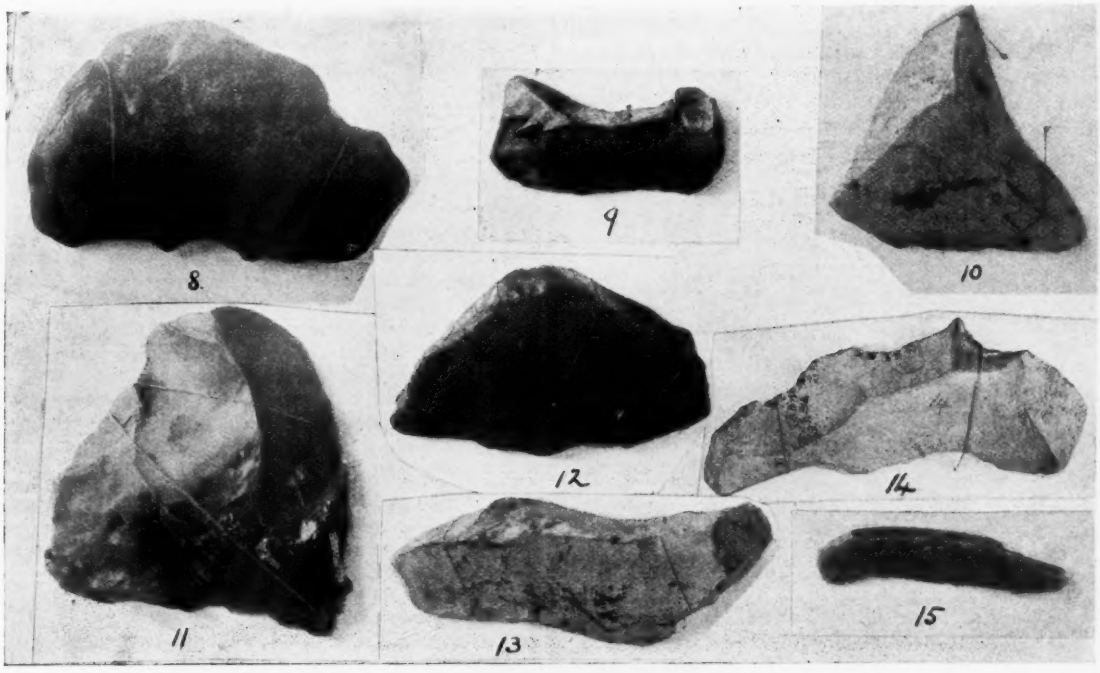


Reproductions of Flint Saws referred to.

Three examples of each were selected, showing the slight variations that might be expected in objects made by different individuals, and at different periods; but for want of space one only of each type can be represented here.

No. 1 represents a form of the saw most frequently met with in deposits of every age; the simplicity of its design made it easy of manufacture, and it appears in considerable numbers from the earliest palæolithic to the latest neolithic period. The lower edge is chamfered or bevelled, and the serration varies much in different examples, the teeth of some being few and coarse, of others numerous and fine; as a rule the older the implement the coarser the teeth. The specimen figured is from Addington, Surrey.

No. 2: The back of this saw is convexly curved from the butt to the point. Occasionally, like the figure, it is toothed on both upper and lower edges, and in some cases is provided with a pointed projection on the back, to serve as a borer. A remarkably fine specimen is figured by the late Mr. J. Allen Brown as a palæolithic knife flake.* The specimen here figured is from Shirley.



Reproductions of Flint Saws referred to.

* "Palæolithic Man in N.-W. Middlesex," pl. ii., fig. 144.

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No. 3 resembles No. 1 in outline, but is made from flakes thin at one edge; thus avoiding the necessity of the bevel, and some specimens are very thin, like the one shown, which is from the surface at Addington. This form might be considered a variety of No. 1.

No. 4 is the short two-edged saw with median ridge, of frequent occurrence in the lake-dwellings of Switzerland, and also in Scotland. The figure represents this type *in excelsis*; as is usual in these double saws, one edge is more finely toothed than the other. This was found at Shirley.

No. 5: One of the most remarkable and persistent forms; enduring without material alteration from the earliest period at which tools were made, until the latest neolithic times. This specimen is from a factory at Addington, and has evidently never been used.

No. 6: These are brought to a point at the narrow end, and somewhat resemble in form the modern "keyhole" saw.

No. 7: This, like No. 4, is a double-edged saw with median ridge, but of elongated form, and with parallel edges. This specimen from Dawley, is from the collection of the late Mr. J. Allen Brown, by whom it was presented to the author.

No. 8: Its perch-backed form well differentiates this from other types. It appears to have been more favoured in the earlier than the later part of the Stone Age. The present large dark-brown example, the appearance and "work" of which mark it as of Eolithic Age, possesses only three coarse teeth, and is from the gravel of the River Wandle at Croydon.

No. 9 has a thick back, hollowed for convenient holding in the hand, while the working edge is straight. The specimen figured is from the Lea gravel at Enfield, and exhibits the polish, due to attrition, which characterises so many river-drift implements.

No. 10: This deltoid form, was plainly intended for hafting, and its occurrence in this country does not seem to have been previously noted; though Bavarian specimens are described and figured by Munro.* It was probably fixed in its handle by bitumen or some other kind of cement. This example is from Addington.

No. 11 has the shape of an ordinary scraper, bevelled to a straight thin edge, which is well serrated. This fine river-drift specimen from Maidenhead is from the collection of the late Mr. J. Allen Brown.

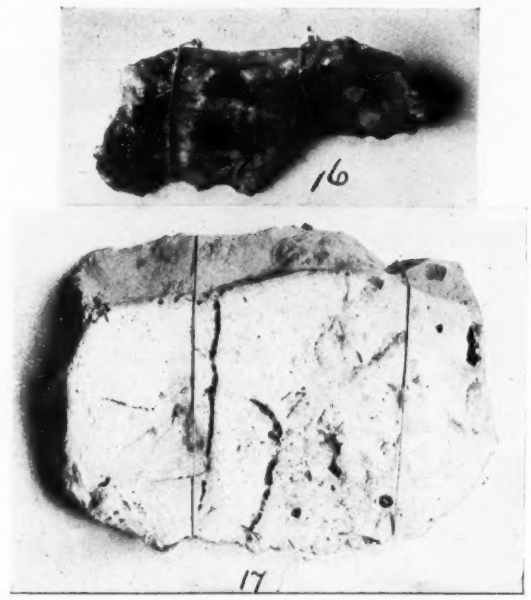
No. 12 in outline closely approaches an equilateral triangle, and is usually massive. Like the last, it was apparently intended to be held in the hand without hafting. The serration of this dark-brown specimen from West Wickham is somewhat indistinct in the figure.

Nos. 13 and 15 are saws with short handles, of scarce forms, and ranging in age from the earliest to the latest periods. These handled-saws vary much in shape.

No. 14: In this rare type the teeth of the saw are along the hollow curve of the thin under edge, and the handle is longer than in the preceding forms. The specimen, from Botley Hill, in the figure bears on the back a short spike, apparently intended for boring purposes.

No. 16: This is an uncommon and curious type, the cutting edge is straight and very short; in the example figured it is even shorter than the handle. The teeth are few and coarse, though in some of these saws the serration is minute.

No. 17: In early times this form of saw was large, coarse, and massive; and was probably held in the unprotected hand. In the Neolithic period, however, it was of thinner and lighter make, and was inserted in



Reproductions of Flint Saws referred to.

a groove, in a short handle, which could be conveniently grasped, and formed the back of the saw. Three examples are figured and described by Dr. Munro, who states that it is the commonest form of saw found in the Swiss Lake Dwellings.* It does not appear, however, until now, to have been noticed in England. The example figured is from Addington, and is probably of early Neolithic age.

* "Lake Dwellings of Europe," pp. 153, 155.

"Knowledge" Calculator.

SOME months ago we announced our intention of bringing out a new Calculator of simple form, enabling anyone to do rough calculations in an easy and rapid manner. At last a satisfactory pattern has been obtained, although very considerable difficulty has been experienced in getting it to work with accuracy. It may not be realised by the ordinary reader that even though a plate may be made with the greatest care and exactness, yet the prints from that plate are very liable to show slight distortions, enough to interfere with the true accuracy of a slide-rule. The new model, however, made by the well-known firm Messrs. W. F. Stanley and Co., has overcome all difficulties, and the instrument, the cost of which has come to much more than was originally expected, may now be obtained at our office. (*Vide* advertisement pages.) Such an appliance is bound to prove a most invaluable companion to all those who have frequent calculations to make.

* "Lake Dwellings of Europe," pp. 6, 126, 140.

The British Association.
A Retrospect of the Addresses.

THE British Association for the Advancement of Science held its 78th meeting at Dublin, and the Presidential Address was delivered on September 2 by Mr. Francis Darwin, F.R.S. In his Presidential Address, Mr. Darwin dealt first of all with the movements of plants, which were used as an illustration of the meaning of stimulus and reaction. He then went on to establish the modern point of view that permanent changes in form, that is, morphological changes, are regulated in a similar way, and brought out the important fact that something equivalent to unconscious memory or habit rules both types of reaction. This led up to a re-statement of Hering's celebrated thesis, that memory is a universal function of organized matter, illustrations being provided by a consideration of ontogeny, that is, the development of the adult from the germ cell. The way was thus prepared for a discussion of the problem of the inheritance of acquired characters—a problem as to which Mr. Darwin did not pretend to be able to offer a final solution.

METEOROLOGY.

On September 3 the whole number of the Presidential Addresses to the Sections were delivered; and thus an excellent start was made with the business of a meeting which was this year unusually full of papers of importance. Dr. W. N. Shaw, F.R.S., the Director of the Meteorological Office, occupied the chair of the Mathematical and Physical Section and offered an apology for presenting to the Section such results as were the outcome of his own experience. Meteorology, he left his hearers to infer, was too often a matter of collecting statistics and data. There was a tendency, he observed, to consider that a meteorological establishment could be regarded as alive, and even as in good health, if it kept up its regular output of observations in proper order and up to date. Initiative in discussing the observations was believed to be exclusively the duty of a central office. That was a view which he should like to see changed. To him, he confessed, the speculation which might be dignified by the name of meteorological research was the part of the office work which made the drudgery of routine tolerable. The production of such and such volumes of data and mean values as a solid contribution to science left him cold and unimpressed. Dr. Shaw went on to define the peculiar and rather embarrassed position of the Meteorological Office of Great Britain, which had to produce results which could be assumed to have a definite and immediate value, but was not in a position to spend money on speculative inquiries. There were inquiries and investigations and problems connected with meteorological data which might be resolved if attacked by competent mathematicians. Some of these Dr. Shaw instanced, and he showed how, by methods of harmonic analysis, most valuable laws and generalisations might be persuaded to emerge from the collected and otherwise unrelated statistics. Finally he pleaded for the establishment, not only by the country, but by meteorologists themselves, of better systematised methods of inquiry and research.

MR. FRANCIS DARWIN.
A sketch from life by V. Monkhouse.

CHEMISTRY.

In Dr. F. S. Kipping's Presidential Address to the Chemical Section, he first considered the steps that should be taken to arrest the decline of the chemical industries of Great Britain and Ireland, and to restore them to the prominent position they had formerly occupied. He proceeded to discuss the probable effect of the new Patent Act on these industries, and concluded that notwithstanding its many points of utility it would not materially benefit British manufactures, as it did not touch the main causes of their comparative failure hitherto. This failure was traced to the functions and training of the works chemist, which have produced a disastrous disbelief in scientific methods, and have created a demand for so-called "technical education." All such "technical education," it was argued, was extremely unsatisfactory as a training for the works chemist. A more suitable educational course was suggested, as well as measures for bringing universities and polytechnics into touch with the manufacturers, by which both would benefit.

GEOLOGY.

In the Geological Section, the President, Professor Joly, delivered an address on "Uranium and Geology." He stated that it could not be doubted that uranium was the primary source of supply for radium, but that it was a fallacy to think that radium was "ceaseless," for the heat outflow gradually diminished. The full and ultimate analysis of the many geological changes arising out of the presence of radium in the earth's surface materials would require to be carried out when experiments had been multiplied, and this was particularly the case in regard to oceanic deposits.

GEOGRAPHY.

The most popularly interesting part of Major Hill's address to the Geographical Section was the account he gave of the present position of the scheme which aims at measuring the earth along a great arc from the South to the North of Africa. At the present moment, he said, the chain had been completed from the south to within seventy miles of the southern end of Lake Tanganyika, a distance of about 1,700 miles. At Lake Tanganyika it would enter into German territory. Meanwhile the German Government, recognising the great practical value of the scheme, were already taking steps to start work in their own section. An International Commission was busy with the boundary section between British Uganda and the Congo State, and thus work on the arc was proceeding in that region also. Owing to Sir David Gill's perseverance a scientific observer was with the Commission. North of the Congo State territory the line came into the British Soudan, and, traversing this, emerged in Egypt, where its interests were safe in the charge of Captain H. E. Lyons, the director of the Survey Department of Egypt. Thus, though the measurement of the arc was some way from completion, they were in the satisfactory position of being able to look forward to seeing it finished within a reasonable period.

ZOOLOGY.

Professor Sidney F. Harmer took for his subject, in addressing the Zoological Section, the importance of zoology in relation to practical matters. In these countries they were fortunately spared some of the worst foes of vegetation which devastated other lands, but it was to be hoped that some systematic measures would be taken to disseminate the knowledge by which injury to agriculturists may be minimised. In England, Scotland, and Ireland the public departments had for some time carried on scientific fishery investigations. Food-fishes and the organisms

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on which they exist was a complex study, but one of immediate practical utility.

BOTANY.

Dr. F. F. Blackman took for the subject of his Presidential Address to the Botanical Section the manifestations of the fundamental laws of physical chemistry in the living organism. The importance of critical quantitative work upon vital processes was insisted upon, and it was further shown how far the data relating to growth, assimilation, and respiration exhibit the workings of the chemical laws, of mass-action, catalytic action, and the acceleration of reaction velocity by temperature.

ENGINEERING.

Mr. Dugald Clerk, presiding in the Engineering Section, dealt broadly with the laws of thermo-dynamics as applied to heat engines in his Presidential Address to the Engineering Section. More particularly, he followed the work of Lord Kelvin, from his meeting with Joule in 1847 to his acceptance in 1850-51 of the dynamical theory of heat. In order to estimate what Lord Kelvin did for the theory of heat engines, Mr. Clerk cited the opinions of some of the most prominent British engineers as expressed at a meeting of Civil Engineers in 1853, and compared the state of knowledge on the scientific side of heat engines at that date with what is known to-day.

PHYSIOLOGY.

In his Presidential Address to the Physiological Section, Dr. J. S. Haldane, F.R.S., Fellow of New College, and Reader in Physiology in the University of Oxford, contended that in physiology and biology generally we dealt with phenomena which, so far as our present knowledge goes, differ not only in complexity but in kind from physical and chemical phenomena, and that the fundamental working hypothesis of the first named must differ correspondingly from that of the latter. It was true that the history of the progress of physiology shows that it has been dependent on that of physics and chemistry, but when it is asked what progress has been made towards the physico-chemical explanation of physiological processes controversy was begun. Dr. Haldane asserted that the conceptions of physics and chemistry are insufficient to enable us to understand physiological phenomena to make them intelligible or to obtain a general conception as to their nature. The problem, stated generally, was not to obtain piecemeal physico-chemical explanations of physiological phenomena, but to discover by observation and experiment the relation to one another of all the details of structure and activity in each organism as expressions of its nature as an organism.

ANTHROPOLOGY.

A controversial note was given to the discussions of the anthropologists by the address of their President, Professor William Ridgeway, "The Application of Zoological Laws to Man." The anthropologists it was who first declined to place man on a platform different from that occupied by the lower animals; but this fundamental principle of anthropology, the President declared, had not been carried out to a logical conclusion. It was the failure to recognise that mankind was regulated by the same laws as the rest of the animal kingdom which not only impeded the scientific study of the history of man, but led to the maladministration of native races and caused us to blunder in social and educational legislation. He showed how, for example, the idea of a superior "Mediterranean race" was beset with hopeless difficulties; and how the origins of races were obscured by the want of a frank recognition of the application of zoological laws to the evolution of races. Professor Ridgeway went on to argue that our ideas of the government of savage races would need considerable modification if we would but recognise that as physical type varies from zone to zone so institutions and religious ideas would also vary. It was consequently folly to seek to govern our great dependencies on the principles of the English Constitution and English law. Finally, Professor Ridgeway pointed out that, though the doctrines of evolution had been known for half a century, and the phrases "survival of the fittest" and "natural selection" were in everyone's mouth, yet British statesmen declined these principles in favour of those which encouraged the reproduction and multiplication of wastrels and of just those classes of the community which were of the least value to the State. At the same time the burdens of the middle class, the most valuable human asset of any country, were so increased that a steady diminution of their reproductiveness was everywhere apparent.

EDUCATION.

Professor L. C. Miall addressed the Educational Science Section on "Useful Knowledge." He rejected as unfit the knowledge which was the result of the mere accumulation of facts. Exercise of the memory, he remarked, involved nervous strain, and after an early age considerable nervous strain. It was more economical and more businesslike to employ mechanical contrivances rather than brain tissue for such purpose, and to leave the vast mass of "useful facts" in grammars, dictionaries, and text books, and to collect those for which we had an immediate use in the notebook or the card index. Happily for us a great deal that we once knew quickly faded from the memory. He pictured to himself a stream gliding past, and bearing along a miscellany of facts, any one of which might possibly be useful at some future time. Now and then we stretched out a hand and grasped something which took our fancy. In nine cases out of ten we dropped it immediately. Only a small fraction of the knowledge which entered the mind of an inquisitive person was kept for so long as a month! Having thus disposed of the species of education which merely stuffs the youthful mind with facts, Professor Miall went on to examine with impartial mind the advantages which a purely scientific education might be supposed to bestow. His verdict was very strongly given against a scientific smattering. An elementary knowledge of many sciences was, he pointed out, becoming less attainable because the standard was constantly rising, and it was becoming less applicable to work in after life, because business now required and commanded the science not of the smatterer, but of the expert. Business demanded now the very best science that the age could supply, and it could afford to pay high enough to get it.

AGRICULTURE.

The Economic Science Section, a sub-section for matters relating to agriculture, had for its President Sir Horace Plunkett. The President said that he desired to establish the claim of agriculture to a wholly new position in the domain of science, and the claim of science to a more intelligent regard from those who apply its teaching to their industry. The problem of rural life was clamant for solution. The city captured increasingly the best elements in the country, and this determination of blood to the head became more and more a threatening system in our national life. The problem demanded proper attention. The British Association depended not upon its highest achievements in the region of pure science, but upon the degree in which it established and maintained a mutually helpful relationship between science and productive effort. Farmers were more backward in business than in technical methods. They wanted organising, but co-operation for agriculture had a far higher aim than immediate business advantage. Its bearing on small holdings was a most important question. Everybody admitted that agricultural co-operation was beneficial in inverse proportion to the economic standing of the farmer, and that the isolated small holder would have a very doubtful prospect to face. Yet neither in Great Britain, where small holdings were being multiplied, nor in Ireland, where the people were on the land, but where vast numbers of them had to be resettled on new holdings, had nearly sufficient thought been given to this aspect of the question. It was a matter of immense importance to consider whether the family should be the unit in our schemes for reconstituting our rural social economy, or whether it would not be sounder to treat communities as units. Otherwise they might preach co-operation, but it would not be practised.

In the Economic Science Section proper, Mr. W. M. Acworth delivered an address on "The State in Relation to Railways." The address fell into two parts—(1) The recent history of the question and (2) suggestions as to the point of view from which it should be approached. An attempt was made by Mr. Acworth to estimate the relative importance of the various factors involved when considered in relation to countries which differed very widely in political constitution, habits, and railway history.

THE long-expected third volume of Crowe and Cavalcaselle's "History of Italian Painting" will be published by Mr. John Murray next month (November). The volume will deal with the Sienese School of Painters, and as this is a subject which the editor, Mr. Langton Douglas, has made his special study, it can hardly fail to throw new light on several debated points concerning primitive Italian painting. In spite of many new theories, the work of Crowe and Cavalcaselle remains a classic work of reference.

On the Retrograde Motions of Some Members of the Solar System.

By S. T. PRESTON, Ph.D.

THREE retrograde orbital movements, at least, appear now to be recognised in our own system, (1) the satellite of Neptune; (2) the outermost satellite of Saturn; (3) the recently-discovered eighth companion to Jupiter.

According to the Nebular Hypothesis of Kant and Laplace, the outlying member of any planetary family represents the first-born of the system.

One recognised perturbing constant cause tending to deflect the rotation axes of the planets is the tide raised on them by the sun (the primary body about which they orbitally circulate).

A gyrostat balanced in gimbals, when given an orbital motion (say, by holding it at arm's length and slowly revolving upon one's heel), will tend to set its axial spin in the same direction as that of its orbital revolution, with its equator in the plane of its orbit; the gyrostat instantly reversing its spinning axis, when the direction of its orbital motion is (artificially) reversed.

A gyrostat and a spinning planet being comparable, the deflecting force on the latter being the persistent tidal action of the sun, the planet, if it happens to spin axially in a retrograde direction, *i.e.*, in a direction opposite to that of its orbital revolution, will gradually, under the solar deflecting force, adjust its spinning axis in such a way that axial and orbital revolutions become ultimately coincident in direction, and striving to reach one and the same plane, provided the planet's equator be not already coincident with the plane of its orbit.

Assuming for the purpose of our argument the view most prevalent, that the Nebular Hypothesis requires the fact to be general that the axial rotation of each planet at its origin was retrograde; then the gyrostatic deflecting action of the sun would tend ultimately to invert the spinning axes of all the planets, bringing their equators into coincidence with the planes of their orbits.

Now, since the outermost satellite of any system must be the first-born of the family, it follows that at the date of origin of the outermost satellite, the time which had already gone towards inversion of the axis of the (presumed retrograde revolving) parent-primary was but a small fraction of the total time expended in the throwing off of the entire system of satellites. Accordingly, the position in space of the plane of the orbit of a first-born satellite would localise the position in space occupied by the equatorial plane of the parent-planet at that early period of its life-history when the first satellite arose.

And until the deviation of the axis of the parent-planet had at least passed 90°, its axial spin would be still retrograde, and therefore the orbital revolution of the outer satellite (concomitantly) retrograde. The retrograde character of the orbital career of an outer off-shoot from a planet may then simply mark the (retrograde) axial spin which the parent had at the date of origin of the satellite; while the further lapse of time demanded for the creation of the inner satellites to commence, might condition *their* origin with *direct* orbital revolution, provided the gyrostatic deflection of the spinning axis of the primary under persistent solar influence had then, at least, passed beyond 90°. In a recent issue of *Nature* (May 14) is a letter by George Forbes, where the retrograde circulation of the newly-discovered companion to the Jovian system is employed as an argument against its being an off-shoot from the planet Jupiter, and it is suggested that we may preferably assume here an instance of a captured comet.

But if in the case of an outer planetary companion, retrograde orbital circulation about the primary can be indicated on any grounds to be *à priori* probable (rather than the contrary), the implication of the cited view in the above letter would be reversed.

The observed generality of the fact that in our own system the spinning axes of the planets are *not* located normal to the ecliptic plane (or to the planes of their orbits), added to the fact that the solar deflecting influence would ultimately set their axes normal, goes certainly to show that these axes were once further removed from the ecliptic plane than now, and consequently it only requires some commensurate realisation of the evidence for the immense epoch of time elapsed since the initiation of the solar system, to justify the inference that the rotation axes of all the planets were once inverted,* implying that at the origin of each member of our planetary system retrograde axial rotation was general.

CORRESPONDENCE.

The Zodiacal Light.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—With regard to the interesting paper by Mr. J. E. Gore in your September number, p. 199, one remark occurs to me to make, namely, with reference to the brightness of the zodiacal light. Mr. Gore states, "In the West of Ireland I have seen it *nearly as bright* as the brighter portions of the Milky Way." (The italics are mine.) "Astronomy for Amateurs" (J. A. Westwood Oliver), p. 293, speaking of the zodiacal light, says, "In the brightest visible part of it, it is several times as bright as the brightest part of the Milky Way visible in northern latitudes." This accords with my experience at Sunderland. It is true that here we cannot see well the brightest part of the Milky Way, namely, that north of γ Sagittarii, but probably this is the case also in the West of Ireland.

Sunderland. Yours, etc., T. W. BACKHOUSE.

Insulation.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—During the recent camp of the St. Helens Engineers it became necessary to run out cable for a distance of 6 to 7 miles. A single insulated cable was run out except for the last mile and a half, when, owing to this cable giving out, the remaining distance was covered by ordinary galvanised naked wire. This latter was laid over trees and bushes, and even along the grass itself, lining the bank of the River Lune. A single wire being used and an earth. The line worked most satisfactorily for telephonic purposes. No insulation was used on the naked wire. Why did not the current earth? The wire was in use for at least 48 hours, and although no rain, there was a very heavy deposit of moisture during the night and early morning.

Yours, etc., NOVICE.

P.S.—The electrified railway line also ran parallel to the cable at a distance of about 600 or 700 yards for about half the distance.

[Although the moisture undoubtedly carries current to earth it does not short-circuit completely. And though the result seems somewhat surprising, yet it must be remembered that most of the precautions necessary in ordinary practice arise from the neighbourhood of other wires, which were absent in this case—A. W. P.]

* This contribution may be said to be in some sense supplementary to an article in the *Philosophical Magazine* for August, 1907, p. 265.

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Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Exhibitions. The annual exhibitions of the Royal Photographic Society, at the New Gallery, Regent Street, and of the Photographic Salon, at 5A Pall Mall East, are now open. In both these is a very considerable number of "autochromes," and now that we know fairly well what these colour plates of Messrs. Lumière are capable of, the chief interest in connection with them lies in the character of the subjects for which they are found useful and in the subjects themselves. The autochromes shown vary a good deal in quality, but the falling off from the high standard known to be possible is due to the workers rather than the plates. The most interesting at the Salon are four "snap-shots," by Mr. A. L. Coburn, but he omits to state the duration of the exposures that were given. At the Royal Photographic Society, Dr. H. G. D. Brockman shows a series of autochromes of various articles of clothing and of a beer bottle, taken in connection with a murder case, to demonstrate the existence of blood stains on them. The objects were subjected to moist oxygen before being photographed, to make the red colour of the stains more obvious. He shows also eight pictures of medical and pathological subjects, from which those interested will be able to judge as to the usefulness of this process for such work.

In the scientific and technical section at the New Gallery there is an interesting collection of photographs of natural history subjects. Mr. Douglas English is probably the first to successfully photograph the stoat, and he shows two examples. Some excellent low-power photomicrographs of beetles (× 5 and × 10), by Mr. W. F. Cooper, series illustrating the domestic habits of the song thrush and the life history of the tawny owl, by Mr. Alfred Taylor, and somewhat similar series of the wood lark and the song thrush, by Mr. William Farren, are among the most notable in the collection. This section includes a few spectrum photographs, one by Mr. V. M. Slipher, which demonstrates the presence of water in the atmosphere of the planet Mars, and a direct photograph in colour of the solar spectrum on "Uto" paper, by Mr. C. P. Butler, which shows how well the dyes used in its manufacture have been selected. There are many other exhibits of scientific interest, besides the galleries of pictorial and professional photographs, and the trade stalls.

A New Colour-plate—The "Thames." Although the "autochrome" plates yield such excellent results, it is only to be expected that experience with this, the first plate of its kind commercially manufactured, should reveal details that one believes and hopes can be improved upon. Perhaps the chief of these, so far as the user of the plates is concerned, are the considerable loss of light due to the opalescence of the starch grains and black pigment that fills the interstices, and the cost of the plates. Many inventors, including Messrs. Lumière, have busied themselves with the endeavour to prepare a more efficient colour-screen and at less cost, and from time to time methods have been referred to in these columns, but still the "autochrome" remains without a competitor. However, it is fully expected that another colour plate, the "Thames," will be purchasable either by the time that these lines appear in print or very shortly afterwards. The colours on this plate are very transparent, and excellent results have been obtained with comparatively short exposures. The first of the three colours is put upon the plate in regularly arranged discs of about $\frac{1}{250}$ inch diameter and of such an area that they cover exactly one-third of the surface. The second colour is arranged exactly like the first, but in the spaces between the first series of discs. Two-thirds of the plate are thus covered, and the remaining third, the spaces between the two series of discs, is covered with the third colour. As the whole plate is covered with the colours there is no need for any black filling. Doubtless the discs of colour will be made smaller eventually, if only for special work.

"Uto" Paper. The "Uto" paper, which has been referred to during the last year or two, contains three fugitive dyes in the film, and gives direct colour prints when exposed under coloured transparencies by the bleaching-out of the dyes not required to give the colour of the transparency. Dr. J. H. Smith, of Zürich, who is the maker, reports in the *British Journal of Photography* as to his progress in the improvement of it. The time of printing has been reduced to about a quarter of an hour for such positives as window transparencies, and one to two hours for autochromes, in both cases in full summer sunshine. The difficulty in the way of a further reduction of the time necessary is the inability to further increase the sensitiveness (or instability to light) of one of the dyes, the other two being easily made four times as sensitive as at present. It is exceedingly difficult to arrange that the three dyes shall bleach-out at an equal rate, a condition that is obviously necessary for success, though it is possible by the use of colour-screens to regulate the incident light and so compensate for differences in speed of bleaching. The removal of the sensitiser, generally anisol, constitutes the "fixing" or desensitising process, and the more thoroughly this is done the less fugitive will the final print be. Dr. Smith finds that a vegetable oil, thinned with benzole, is better than benzole itself, which was previously employed for this purpose. Two or three baths must be used. A difficulty in printing with autochrome plates is that in direct sunshine the plate gets hot, and the varnish may melt. This was so with autochrome plates obtained last year, and unvarnished plates were used. But this year's plates, even unvarnished, will not stand the heat, for the varnish in which the starch granules are embedded has a lower melting point than before and is liable to soften, the result being that the dyes in the granules mix, and lead ultimately to a print in black and white. This is obviated by spraying water upon the cover-glass of the printing frame.

Miscellanea. *Marion & Co.'s Competition.*—This competition, in which many prizes are offered, some of considerable value, closes at the end of this month. In addition to the more usual classes, it includes a class for photographs of scientific interest, using that expression in its widest sense. Full details can be obtained on application to the firm at Soho Square.

Dallmeyer's "Penric" Cameras.—These cameras are of the light folding pattern so well known, and are made for roll films or plates, or both. The most striking deviation from previous designs is the very substantial "fork" cast solid in magnalium, so that it is light as well as strong, that carries the lens. A descriptive booklet may be had on application.

Solar Disturbances During August, 1908.

The increased activity of the sun has been maintained during August. On the 1st of the month the longitude of the central meridian was 68° 9′ at noon.

Nos. 107, 109, and 110 are repeated from July as they continued visible until August 3rd, 10th, and 12th respectively.

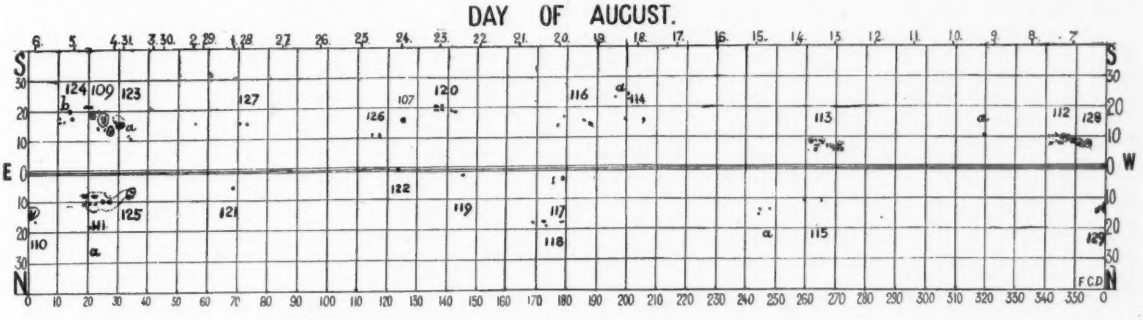
No. 109*a*.—In area of 97*a* a pore showed 4th, 5th, and 8th, accompanied by a gray companion on 4th.

No. 109*b*.—Three pores in faculæ on 10th, which had become a larger spotlet by 11th.

No. 111.—A pore on 1st, three larger on 2nd, increasing. Showed considerable activity, of elliptical order. The length became 66,000 miles, and its largest member 11,000 in diameter. August 1st to 11th.

No. 112.—Two pores on 4th, increasing to an elliptical group on 6th. The leading spot grew to 22,000 miles, the group 75,000 miles, visible to the naked eye. 4th to 13th.

No. 112*a*.—A pore only seen 13th.



No. 113.—Between 8.45 and 11.30 a.m. on 12th two pores showed 23,000 miles apart, widening and increasing in size during the day. Elliptical 13th. The group attained a maximum length of 92,000 miles, with 22,000 miles diameter for its leader. 12th to 19th.

No. 114.—A pore 13th almost buried in faculæ, a group 15th, the leader growing to 6,000 miles in diameter, and the group 50,000 miles in length. Only one spot seen after 18th. 12th to 23rd.

No. 115.—A group of pores 50,000 miles in length, in faculic area, 13th to 16th.

No. 115*a*.—A similar group of pores 33,000 miles long, connected with the last. 13th to 17th.

No. 116.—A small spot 13th, three 15th, increasing to a group 88,000 miles in length, but the components all small. Dwindled after 22nd. 13th to 25th.

No. 116*a*.—A pair of pores on 21st, a group 42,000 miles long 22nd, then decreased till 24th, when it was close to limb.

No. 117.—A spotlet within limb 14th, with pores 15th in morning, only a gray pore in evening, and on 16th when last seen.

No. 118.—A group of pores 16th, protean in appearance, of varying length. On 20th to 22nd, a spotlet with a gray pore 9° distant, and sometimes having pale formations between the two.

No. 119.—A pore only visible 22nd.

No. 120.—A partially formed ring group of pores 22nd, drawn out 24th, 57,000 miles long, a double group 25th, two pores remaining 27th and 28th when last seen.

No. 121.—A pore seen 22nd to 24th.

No. 122.—A pore on the equator 27th and 28th.

No. 123.—A spot 23,000 miles in diameter closely ahead of No. 109. A pore east 28th and 29th. Later in day an ellipse of pores showed south-east, some of which remained visible until it reached the limb on September 6th.

No. 124.—A small spot 17° east of No. 123, perhaps connected therewith, 27th to September 2nd.

No. 125.—A fine and active group, though largely penumbral, finally breaking up into spotlets and pores. 24th to September 6th.

No. 125*a*.—Pores showed in a faculic mass on 26th. A pair 27th to 30th 14,000 miles apart. A close pair August 31st and September 1st.

No. 126.—A pair of pores 27th and 28th. On 29th nothing visible, but on 30th an incomplete ellipse of pores had developed very near the preceding limb.

No. 127.—A little group of pores seen 26th to 28th.

No. 128.—A spot 20,000 miles in diameter, a return of No. 112, a little ahead of its former position. August 28th to September 9th.

No. 129.—A pair of little pores broke out on 29th directly over the place of No. 110, and became a considerable group 50,000 miles in length by 31st, then decreased till only a tiny pore remained on September 7th.

The diagram is constructed from the observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett, compared with Mr. A. Mee's drawings.

Birkbeck College.—The new session at Birkbeck College has just opened, and day and evening classes of courses of instruction adapted to the examinations of London University are now in progress. Among the subjects which receive the attention of recognised teachers of the university for degrees in Science, Arts, and Economics are Chemistry, Physics, Botany, Zoology, Geology, Mathematics (pure and applied), Languages, Classics, Geography, History, Logic, and Economics; while instruction is also provided in Assaying, Metallurgy, and Mining. Further information can be obtained from the Secretary, Breams Buildings, Chancery Lane, E.C.

XUM

The Employment of High Magnifying Powers.

By W. F. DENNING, F.R.A.S.

AT various times I have tried experiments with regard to high magnifiers* for planetary work with a 4-inch Cooke refractor and reflecting telescopes having mirrors of 10-inch (With) and 12½-inch (Calver). I found that as a result of various trials considerable powers were not very effective in grasping detail, although there were rare occasions when they performed satisfactorily. As a rule, however, the greatly magnified image showed an indefiniteness of detail and amount of vibration, combined with so rapid a motion across the field, as to destroy any advantage which might otherwise have accrued. The definition with powers of about 200 to 250 was really magnificent, and with from 290 to 335 often very sharp, but 405, 420, and 440, and any excess of the latter number usually proved disappointing, and sufficiently indicated the uselessness of overpressing the power. During the progress of observation I found that the ordinary Huyghenian eye-piece, and other two-lens combinations, performed very badly in camparison with single lenses. The superiority of the latter in regard to high powers, seemed in fact, quite striking as regards both light and definition, but, of course, this only applied to the centre of the field. With several ordinary eye-pieces magnifying about 710 the definition of Jupiter even on a steady night became very bad, whereas single lenses of similar powers and one of 912 gave pretty good results. On November 6, 1905, I tried a single lens magnifying 1,540 on Jupiter. The image was fair (sufficiently so, indeed, to surprise me), and all the details seen with powers of 300 could still be distinguished, though there was considerable difficulty in getting the image central. In fact, the efforts of the observed had to be concentrated rather upon bringing the object into the field and keeping it well there than upon the thorough examination of the disc, which could only be partially and hurriedly done in a way affording very little encouragement. The view, however, was so good as to be astonishing apart from the disadvantages attending it.

Employed with the ordinary alt-azimuth mounting, very high powers can never be really efficacious, owing to the fugitive and vibratory character of the images.

Of course, the powers most suitable depend in a great measure upon the character of the night, for there are occasions when telescopes will pretty successfully bear abnormally high powers.

On August 16, 1905, the elongated shadow of Jupiter's Sat. III. on S. limb was beautifully seen with 315,440 and 572 on 12½-inch Calver.

With concave lens and Barlow = 168 Jupiter appears a grand and brilliant object splendidly defined, but the field is small.

Huyghenian eye-pieces 420 and 440 on a really good night are fairly effective; 572 is too high unless conditions are exceptional and object special. Kellner eye-pieces I have found very excellent, but I have not used powers of over 105. Steinheil's monocentric oculars are remarkably good, giving sharp, bright images.

Whenever high powers are required for any particular studies of planetary configuration and the air is steady enough to warrant their employment, they should be single lenses or single lenses used in combination with a Barlow. Of course, spherical aberration in the case of the single magnifiers is a serious deterrent, but if critical observations are required they are decidedly more effective than the ordinary eye-pieces. This, at least, is my experience, and it seems to be but a repetition of the opinion formed by such masters in the field of telescopic work as were Sir W. Herschel and Rev. W. R. Dawes, not to speak of others.

* I possess 65 various eyepieces magnifying from 10 to 2177.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Disturbed Region in Solar Corona of January 3, 1908.

MESSRS. W. W. CAMPBELL AND S. ALBRECHT describe an area of disturbance in the solar corona photographed during the total eclipse of January 3, 1908, at Flint Island, the general appearance being of similar nature to that recorded during the previous eclipses of 1893, 1901, and 1905. Careful measures of the position of the vertex of the cone of disturbance place it at position angle 75°.0 (east of north) and 13'.7 distant from the sun's centre. The disturbance, although on a large scale, does not fix the position of the vertex so definitely as that of 1901, the streamers appearing to radiate from a small area. Photographs of the uneclipsed sun taken at Mount Wilson on the same day have been kindly furnished by Professor Hale, and a distinct region of disturbance, including five or more sunspots, is shown extending from position angle 71°.8 to 82°.0 (east of north) and distant from centre 13'.4 to 14'.8. The estimated position of the vertex of the coronal disturbance is thus seen to fall within the spot group, and it appears scarcely possible to doubt that the disturbance in or near the photosphere is intimately related to the disturbed conical area of the corona. Whether the coronal and photospheric disturbances are related to each other as cause and effect, or more probably, as joint effects of a more general cause, is not known, but the subject is of renewed interest now we have Hale's recent discovery of cyclonic motion or vortices in sunspot regions.—(*Lick Observatory Bulletin*, No. 136, July 31, 1908.)

The Lunar Bright Rays.

Mr. H. G. Tomkins has been at considerable pains to collect data bearing on his theory that the lunar bright rays may be due to extensive incrustations of alkali or similar material left in position after the evaporation of the water which previously held it in solution. The most conspicuous of these ray systems are those of Tycho and Copernicus, each having certain characteristic features. The rays from Tycho branch right away from the crater, radiate in fairly regular streaks, and, in general, are longer than those of Copernicus. In the case of the Copernican rays there is a wide area of white material round the crater sloping away from the walls, and it is from this area that the bright rays branch out. The rays themselves do not radiate from Copernicus, but are complex in their arrangement. Evidence is adduced showing the similarity of the ray structure to the radial occurrence of laccollitic material round certain terrestrial volcanoes, supposed to be the result of original upheaval and subsequent wrinkling on subsidence. The author then considers the terrestrial tracts of country where alkali is known to be present as a distinctive feature; in some cases the surface evaporation is sufficient to produce an efflorescence on the surface, in others the deposit remains underground. Interesting photographs are reproduced showing the striking appearance of the surface tracts, which

occur abundantly in India, Persia, and Africa, one of these being figured below. Diagrams are given showing how the radiating formations could be produced on the sides of

Alkali Efflorescence on Cultivated Land.

hills, and a map shows the details of occurrence of the alkali in the mountain district of the Indian Punjaub.—(*Journal British Astronomical Association*, Vol. 18, p. 361, July 27, 1908.)

Solar Prominences During 1907.

Bulletin No. 13, from the Kodaikanal Observatory, gives detailed results of the prominences observed and photographed during the latter half of 1907, and a summary for the year. The visual observations were made in the C. (Hα) line of Hydrogen, and the photographs taken with the spectroheliograph in the H or K lines of Calcium.

SUMMARY OF PROMINENCES FOR 1907.

	Heliographic Latitude.																	
	North.									Equator.	South.							
	90° to 81°	80° to 71°	70° to 61°	60° to 51°	50° to 41°	40° to 31°	30° to 21°	20° to 11°	10° to 1°		1° to 10°	11° to 20°	21° to 30°	31° to 40°	41° to 50°	51° to 60°	61° to 70°	71° to 80°	81° to 90°
Number of Prominences	49	81	138	348	304	314	413	415	398	36	402	474	436	368	416	289	330	392	218
Mean Daily Frequency (296 days) ..	0·166	0·274	0·466	1·176	1·027	1·061	1·395	1·402	1·345	0·122	1·358	1·602	1·473	1·243	1·405	0·976	1·115	1·324	0·736

Orbit of Jupiter's Eighth Satellite.

From the observations of January 27, March 8, and April 29, Messrs. R. T. Crawford and W. F. Meyer have computed the elements of the new satellite of Jupiter discovered by Mr. Melotte at the Greenwich Observatory. It has been assumed that Jupiter is the primary, and the sun the principal disturbing body. From the characters of the residuals the authors remark that there can be no doubt of the correctness of the supposition that the object is moving round Jupiter as primary.

ELEMENTS OF JUPITER VIII.

Epoch and Osculation, 1908, March, 8.8233 G.M.T.

$$\left.\begin{aligned} M_0 &= 294^\circ\cdot286 \\ \omega &= 51^\circ\cdot143 \\ \Omega &= 236^\circ\cdot204 \\ i &= 145^\circ\cdot795 \end{aligned}\right\} \text{ Equator 1908·0}$$

$$\begin{aligned} a &= 26\cdot073 \\ \mu &= 0^\circ\cdot38680 \\ \log a &= 9\cdot26412 \\ \rho &= 2\cdot5482 \text{ years.} \end{aligned}$$

An ephemeris based on these elements is promised.—(*Lick Observatory Bulletin*, No. 137, August 21, 1908.)

New Variable of β Lyrae Class.

From the examination of the Harvard photographs the star $-26^\circ.179$, RA = 0h. 32m. 29.3s.; Decl. = -26° 6′.5 (1900), magnitude 9.1, has been found to show variability of the β Lyræ type. The variation is continuous, having two maxima of 9.64, and two minima of 10.47 and 9.84 respectively. The period is 0d.511574. Details of the star's brightness were determined from 195 plates, of which 129 were taken at Arequipa; the dates of exposure varied from 1891, January 3, to 1907, October 31. The light curve summarising the photometric determinations is given, showing that the first maximum is somewhat flatter and of longer duration than the second. The spectrum is of class F, intermediate between types I. and II.—(*Harvard College Observatory Circular*, No. 139, July 13, 1908.)

Helium Absorption in Vicinity of Sunspots.

In the discussion of an extensive series of observations made by Capt. R. A. C. Daunt of dark D_3 in the neighbourhood of sunspots, Father A. L. Cortie classifies them according to the type of spot group, using the Cortie nomenclature, so that it is a simple matter to determine whether the appearance of the helium absorption has any relation to the age or degree of disturbance of the spot area. In every case of reversal of D_3 the C (Hα) line of hydrogen was sympathetically affected, being twisted and lumpy, distorted towards the red and violet, and accompanied by brilliant reversals. In the analysis it is shown that 39.7 per cent. of the groups in which D_3 was observed as a dark line were of Types II. and III., representing the more active phases of sunspot development. In the life histories of spot groups it is generally the *following* part of the group which disappears first, leaving a single spot, with accompanying small companions. This phase, Type IV., is also largely represented in the observations under discussion. It thus follows that the phenomenon is indicative of violent local action in the earlier phases of the life-history of the spot groups, but it is not entirely confined to these phases. The spots near which dark D_3 was not observed were generally in the last stages of their life-history.

Comet 1908c Morehouse.

This comet is still faint, being just discernible in a 3-inch telescope, and is probably about the 8th or 9th magnitude. The accompanying ephemeris for the first few days in October is by S. Einarsson and W. F. Meyer, of the Berkeley Astronomical Department:—

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

	R.A.	Decl.	Br.
1908. Oct. 1·5	21 32 25	+ 72° 58′·4	2·73
,, 2·5	18 48	72 05 ·0	
,, 3·5	21 06 23	+ 71° 06 ·9	2·90

Brightness on September 3 = 1·00.

The comet was photographed at South Kensington on September 14, 17, 18, and 21. On the 14th it showed as a nebulous head with surrounding coma and central condensation, with a fairly definite fan-shaped tail, divided into two sections of unequal intensity, extending from the comet in a south-easterly direction. The comet itself is travelling rapidly in a north-easterly direction on the borders of Cepheus and Cassiopeia.

XUM

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

Weighted Silk.

IF we compare the silk dresses of fifty years ago with many of the silk articles manufactured at the present day it needs no elaborate tests to show the superiority in strength of the older material. This is usually due to the fact that silk yarns are now frequently treated with metallic salts, such as tin chloride, which are readily absorbed, forming insoluble compounds and thus increasing the weight of the fibre. So prevalent did this practice become some years ago that even the manufacturers recognised the necessity of putting some limit to it, and, accordingly, a self-denying ordinance was agreed upon between the silk manufacturers of Zurich and of Crefeld, providing that the loading of silk warp should not exceed 20 to 30 per cent., and that of the weft 60 to 80 per cent. Apparently this moderation on the part of the manufacturers did not prove altogether successful, for the agreement was not renewed at the International Conference at Turin in 1905, the subject being referred to a special committee.

Apart from the fact that one is buying a compound of silk with a metal instead of pure silk, this treatment frequently causes the fibres to become excessively tender, especially after exposure to direct sunlight. Thus, in Herr Strehlenert's experiments, it was found that, taking the strength of genuine silk as 50 to 53, the strength of a sample of a loaded French silk containing 140 per cent. of added material was only 7.9.

Not only does the weighting process reduce the tenacity of the fibre and often destroy the dyestuff, but it is also a frequent cause of the appearance of mysterious spots upon a fabric. This has frequently been noticed in the case of silks heavily weighted with tin phosphate and silicate, bright red spots having appeared upon the fabric after exposure to sunlight.

The explanation of these is to be found in the results of experiments made by Mr. Sisley, who found that even a very dilute (half per cent.) solution of common salt acted upon loaded silk in the presence of air and moisture, and produced stains and complete disintegration of the fibre within 12 months. The action of stronger solutions of salt was still more rapid, and the "tendering" of the fibre was very marked after treatment for seven days with a two per cent. solution.

The presence of salt in such stained and weakened silk may be readily accounted for by the fact that salt is a constituent of human perspiration, and may thus have been introduced during the handling of the yarns by the workmen. Special precautions are now taken to eliminate this source of injury, and the disintegrating action of the tin salts upon the fibres is also reduced by a subsequent chemical treatment of the yarn. Hence the weighted silks now sold are frequently stronger than their predecessors of a few years back.

Serum Therapy Exhibits.

A most interesting collection of exhibits is now being shown at the Franco-British Exhibition by the Wellcome Research Laboratories. It includes actual preparations of antitoxic sera to different diseases and to snake venom, as well as specimens of the precipitins, to which allusion has frequently been made in these columns. The nature, properties, and uses of the preparations are concisely described in a little handbook issued by Messrs. Burroughs, Wellcome, and Co., and with the aid of this even the visitor without special knowledge of the subject should be able to follow the development of serum therapy. A similar booklet deals with the medicinal chemical preparations also exhibited by the firm.

A New Method of Preparing Hydrogen.

In the current issue of the *Comptes Rendus* a new method of obtaining hydrogen is described by M. Maurichéau-Baupré. A coarse powder is first prepared by the interaction of a small quantity of mercuric chloride and potassium cyanide with fine aluminium filings, and on adding water to the resulting compound in the proportion of about 1 litre per kilo. hydrogen is slowly evolved, the oxidation of 1 kilo. being complete in about two hours. The hydrogen is very pure, and only the simplest apparatus is required for its production. Since the powder is quite stable if protected from moisture it should prove a useful source of gas for balloons. About 1,300 litres may be obtained from 1 kilo. of the preparation.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

Radium and Geology.

THE address given by Professor John Joly to the Geology Section of the British Association was of intense interest and full of valuable thought. His subject was "Uranium and Geology." He spoke of the relation of uranium to radium as that of grandparent, the recent discovery of ionium by Boltwood serving to link the two. The fraction of uranium which is transformed yearly is so small that the quantity on the earth 100,000,000 years ago was hardly more than one per cent. greater in mass than to-day. Radium has now been found widely scattered over the earth, always greatly exceeding the earth's internal radio-activity, and uranium, the heaviest element known to us, which gives rise to the radium, is for the most part found at or near the surface. Professor Joly finds that the oceans contain about 20,000 tons of radium, and the present condition of the seas is the result of uranium having been poured therein by the rivers over great periods of geological time, the proportion found being greater than in the rivers. Radium as a source of heat for the earth is important to geologists when considering the age and future of the earth. It is possible that the whole heat loss of the earth is now being made good by radio-active heating, and the central core of the earth, with a probable continuous source of heat in itself, is protected from loss by an immense heated mass of material between it and the surface. The end of the earth is farther off than ever. And if the end, so the beginning; geologists need no longer be cabined and confined by the physicists.

Silurian Rocks Under Kent.

An important discovery has to be recorded in connection with the subject of the Palæozoic rocks under South-Eastern England. In the July issue was given an imaginary underground section of the rocks from London to Dover. If reference be made thereto it will be found that I showed a possible rise of Silurian rocks between Crossness and Chatham. I am pleased to say that this has now been proved to be an actual fact, although these rocks reach even nearer the surface than there shown. Mr. W. Whitaker, F.R.S., has kindly furnished me with a copy of his paper read before the British Association in Dublin, and he there shows that Silurian rocks have just been reached at about 1,030 feet below Ordnance Datum, at Cliffe, near Gravesend. Alluvium and river gravel account for the first 77 feet. These rest on about 656 feet of chalk, and no less than about 208 feet of gault. Then come 96 feet of Lower Greensand, whilst this rested immediately on the much older Silurian rock. The fossils *Atrypa reticularis* and *Plectambonites* have been found at 1,063 feet, and have been determined by Mr. H. A. Allen from cores supplied by Mr. Baldwin Latham. As Mr. Whitaker remarks, "It puts a northern limit to the Kent coalfield."

The South-Eastern Coalfield.

An interesting pamphlet has reached me from Mr. Malcolm Burr, F.G.S., dealing with the development of this coalfield. There is a great deal of useful geological material contained in it, independently of its interest to shareholders in the Kent Coal Concessions Company, and its subsidiaries. The Waldershare boring has yielded five good seams of coal, the largest, which measured 5 ft. 2 ins. in thickness, having been found at a depth of 2,372 ft. At 1,818 ft. a seam of 1 ft. 8 ins. was bored through. At Fredville a seam 18 ins. thick was struck at 1,424½ ft., another of the same thickness was encountered at 1,446¾ ft., whilst one of 4 ft. 4 ins. was bored through at 1,505 ft. Test borings are in progress at Barfreston, Goodnestone,

and Woodnesborough, and it would seem that determined measures are being taken to prove the extent and possibilities of this coal-producing area at last. Mr. Burr has written a chapter containing a great deal of information concerning the zones of the chalk through which the various borings have passed, and emphasises their bearing upon the water question in East Kent. He concludes as follows :—

"There are a number of conditions which affect the amount of water present in the chalk of a given district. In deep-seated chalk and in the marly zones we have seen that the water requires fissures to enable it to travel. The relative abundance of these fissures probably depends largely on the position of lines of disturbance. Along an anticlinal axis the chalk is sure to be cracked and broken, whereas in a synclinal basin it will be compact and pressed together; this is probably the reason why Richmond (Surrey) failed to get a good water supply from the chalk. Notwithstanding the depth of the well and the 3,460 yards of headings, the total yield was only 260,000 gallons per day. For this reason it is probable that the water will be less in quantity the nearer the approach to the Sandwich-Pegwell syncline."

I would merely add that the fissures would probably be fewer where there was neither anticline nor syncline.

Cement Rocks in Trinidad.

Mr. R. J. Lechmere Guppy has forwarded a copy of a paper on the cement-producing materials of Naparima, Trinidad. It is of value as showing how geology may prove of economic value to those countries that choose to avail themselves of the knowledge possessed by their own native geologists. There appears to be a great similarity between the cement-producing rocks of Barbados and Naparima. Mr. Guppy has found a wonderful series of *foraminifera* in the chalky rocks of the district, and as there are beds of earth consisting partly of chalky material and partly of fine mud, he has called the attention of the authorities to the existence of these ingredients for the making of cement of the best quality. His conclusions have been arrived at after consulting the most reliable United States authorities on the subject.

Erosive Effect of Mud in Water.

In a lecture delivered by Mr. Guppy before the Victoria Institute he calls attention to the greater erosive effect of water when charged with mud, and I should like to quote his remarks.

"There is a circumstance which appears to me to have been largely overlooked by geologists, that is, the immensely heightened effect of water when charged with mud. Ordinarily when the water is clear the erosion of a stream is really *nil* or almost so, and is chiefly confined to carrying off matters such as lime, etc., held in solution. But when the heavy rains of the wet season come and the swollen river with its waters charged with mud rushes down, the quartz boulders are rolled along like mere trifles and large quantities of sand and gravel are carried away; in the process eroding the banks at every turn and thus securing a fresh supply of detrital matter. The operations of the apparatus used in alluvial gold-mining and called the 'long-tom' are interesting when viewed in connection with the effects of water holding mud in suspension. The way of working this apparatus is for the gold-bearing stuff to be placed at the upper end of the trough, which is slightly inclined; a stream of water is then directed upon it and it is stirred up with hoes. This causes the mud and clay to be quickly carried away, the water passing through the holes in the plate and carrying the finer gravel and sand into the ripplebox, where the particles of gold fall to the bottom and are retained by the divisions of the box, which is filled to a depth of two or three inches with sand and gravel. As long as muddy water flows into and through the ripplebox the sand is kept in a loose state and the gold easily falls to the bottom. But if at any time owing to a stoppage in the supply of fresh material the water becomes clear the sands quickly set or harden, and if then fresh material is brought in and the water becomes muddy again, the gold does not sink into the material in the ripplebox, but it and the gravel and sand are carried off over the surface of the former deposit. Clear water, therefore, causes the settlement of gravel and sand, while muddy water keeps it loose and in an active and lively state, greatly promoting the rapidity of removal. The cause, of course, is the greater specific gravity of muddy water, the gravel and sand consequently almost floating in it and being thereby rapidly moved onwards by the current."

METEOROLOGY.

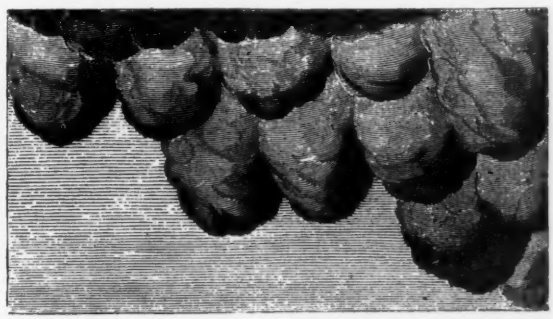
By William Marriott, F.R.Met.Soc.

The Pocky Cloud.

On Tuesday, September 1, when leaving Peterborough by train at 9.30 a.m., I observed one of the most remarkable forms of cloud I have ever seen. This was what is called the "Pocky Cloud." I have occasionally seen festoons on the underside of a thick cloud, as in the "Cumulo-stratus Mammatus," and have usually associated them with the so-called "pocky cloud." I am now inclined to think that they are not the pocky cloud proper. The pocks or protuberances of this cloud were so bold and large that I could not help calling my fellow passenger's attention to them.

The Rev. Dr. Charles Clouston, of Sandwick, was the first to describe this form of cloud, and he said that it was always the precursor of bad weather, and was much dreaded by Orkney sailors.

On September 1 a deep cyclonic system covered the British Isles, so the weather conditions were very rough. At 9.30 a.m., however, the wind had temporarily fallen rather light, and the rain had ceased.



I regret that I was not able to obtain a photograph of the cloud, but the accompanying illustration from Dr. Clouston's pamphlet, "An Explanation of the Popular Weather Prognostics of Scotland on Scientific Principles" (Edinburgh: Black, 1867), very closely represents what I saw. The late Mr. H. C. Russell, F.R.S., of the Sydney Observatory, New South Wales, succeeded in securing a photograph of a somewhat similar form of cloud, but the outlines were not quite so strongly marked as in the above illustration.

Thunderstorms and Hail.

The following letter has been received from "Senex," London, N. :—"In the July number of 'Knowledge' appeared a letter respecting a thunderstorm which occurred at West Norwood on June 4, which was a very hot day, the maximum temperature being 84°, when rain and hail fell simultaneously. Will you allow me to enquire through the medium of 'Knowledge' what explanation can be afforded of such occurrence? How was the freezing produced during the prevalence of so high a temperature, and how was it that the rain was not affected by the frost?"

Thunderstorm formations are small atmospheric whirls—in all respects like ordinary cyclones. As the wind frequently falls light or calm during their occurrence, while there is considerable and often violent motion in the clouds above, and as the thunder-clouds are of no very great altitude, it is most probable that the whirl is confined to a stratum of air only a comparatively little distance above the earth's surface. Sometimes, however, a violent wind occurs during a thunderstorm; this probably takes place when the storm is of low altitude. Under ordinary conditions the temperature of the air decreases roughly about 1° for 300 feet. So with a temperature of 84° at the surface we

should expect to find a temperature of 32° at an altitude of about 15,000 feet. As, however, hail is often formed at as low an elevation as 4,000 or 5,000 feet, we can understand that very great differences of temperature must exist at the time within that distance above the earth's surface, and these will be productive of violent commotions in the air.

Lightning Stroke.

A correspondent who signs himself as "A.A.M.," Hove, writes:—"Can you tell me where I can obtain any information as to the so-called 'Return Stroke' in thunderstorms? I remember reading of it some years ago, but have lost the reference. I think it was stated that persons standing in the street had been killed by a shock when at some distance from the centre of the storm and when no flash had been immediately noted. I ask this because last month (July) a case occurred where a lady, of whom I knew something, had just left her house while a storm was in progress near by, and who shortly afterwards was found quite dead on the pavement. At the inquest the medical verdict was the common one of 'heart failure,' as no mark or wound was visible. But as a sister gave evidence that the deceased had never had a moment's illness in her life and was in her usual health when she left home, and could only account for her death by the supposition that she had hurried and was frightened, I cannot help thinking that this may have been a case of 'return stroke,' and I should be glad of any information on the subject."

The term "return stroke" is very seldom used. It is, however, equivalent to what is now termed "surging." I would refer "A. A. M." to a paper by Mr. Alfred Hands on "So-called Vagaries of Lightning," in the *Quarterly Journal* of the Royal Meteorological Society, vol. 32, p. 195, 1906.

According to the facts stated above, I should be inclined to think that the lady's death was not due to "return stroke," but was the result of "heart failure," as given in the verdict at the inquest.

Rainfall of Australia.

A Commonwealth Bureau of Meteorology has recently been established at Melbourne in order to consolidate the meteorological work of Australia. Mr. H. A. Hunt has been appointed Commonwealth Meteorologist, and he is issuing not only Daily Weather Maps, but also Bulletins on the Meteorology of Australia. No. 1 is on "The Climate and Meteorology of Australia," and No. 2 is a "Rainfall Map of the Commonwealth of Australia." The object of the latter publication is (*a*) to present an authentic map showing the average annual distribution of rainfall throughout the Commonwealth; (*b*) to make known to existing and intending settlers what areas of country abound with quantities of rainfall suitable for the various agricultural enterprises; and (*c*) to dispel many of the erroneous impressions that are current respecting the rainfall of Australia and Tasmania.

The heaviest rains fall over the northern and eastern parts of the Continent, but while this is so, the most reliable, although lighter rains, are experienced over the south-western and south-eastern portions, including Tasmania. The driest part of Australia, that which receives a rainfall of 10 inches and under, comprises an area equalling nearly one-third of the Commonwealth, and including the central territory of South Australia, the extreme western parts of New South Wales, the south-western parts of Queensland, and the south-eastern, central, and part of the north-western portions of Western Australia. One million and eighty thousand square miles of country, or over one-third of the Continent, receive an average of from 10 to 20 inches, and the remaining third enjoys abundant rains, ranging from 20 to 130 inches per annum. The wettest part of the Commonwealth is situated about the Johnston River, on the north-east coast of Queensland, and on the west coast of Tasmania. The highest annual average recorded is 130 inches at Geraldton, in Queensland, and 114 inches at Queenstown, in Tasmania. Sixty inches and over are annually averaged on several portions of the Queensland and New South Wales coasts, and also on the Southern Alps, on the border of New South Wales and Victoria. The least rainfall average in the Commonwealth, 3.8 inches, occurs over a comparatively small area of country in the centre of the Continent to the north of Lake Eyre.

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

Economic Ornithology.

IT would seem that an attempt is to be made to grapple in earnest with the problem of the relation of our native birds to agriculture and the fishing industry, for at the recent meeting of the British Association in Dublin Mr. A. E. Shipley was granted the sum of five pounds to be applied to this end. Mr. Shipley occupies the position of one of our leading zoologists, and in his official capacity in Cambridge has done great service in working out the life-histories of animal parasites. Five pounds, for work of this kind, is, of course, a ridiculously inadequate sum, but we gather the Board of Agriculture is also to assist, though whether with grants of money or by simply conferring a blessing on the work is not recorded.

It is to be deplored, however, that the Board of Agriculture so persistently endeavours to shirk its plain duty. This subject can only be successfully dealt with by the appointment, under the Board, of a staff of trained specialists, for it demands the strictest scientific accuracy and laborious research. Private individuals have rarely the necessary qualifications or the time to devote to this work. Real mischief has already been done by irresponsible advisers to local authorities who have endeavoured to determine the harmfulness or otherwise of certain birds within the jurisdiction of such authorities, and unless Mr. Shipley can command the services of some exceptionally qualified workers, no good can come of this attempt.

So far the Board of Agriculture has done nothing in this matter but issue a few tracts, some of which, for sheer imbecility, would be hard to match.

But it is not only the question of what birds affect man injuriously or confer benefits upon him that the Board is called upon to determine. With this authority should also rest the conservation of birds which, from an æsthetic point of view, also demand legislation to prevent the extermination which now threatens them.

Hoopoe in Ross-shire.

Colonel Murray, in the *Field*, September 19, records the fact that his keeper caught a hoopoe in Geanies, Ross-shire, on September 9.

Food of the Cormorant.

There are those who, with an assumption of knowledge which they do not possess, are untiring in their assertions that the Cormorant is a bird which inflicts incalculable damage on our fisheries. We have never for a moment considered these jeremiads as supported by facts, and are, therefore, all the more pleased to see, in the *Field*, September 19, a note by Mr. C. A. Hamilton to the effect that on two occasions, during a stay at Uyeasound, Unst, he killed "the ordinary black cormorant while fishing among the sea-trout along the beach there. I opened them to see what they had been feeding on, and in neither was there any trace of trout, but in both there were small crabs measuring about 1¼ to 2 ins. across the shell; in one instance there were three, and in the other one. The rest of the contents consisted of 'swarfish' . . . and pilticks."

Green-backed Gallinule in Norfolk.

In "British Birds" for September the Rev. M. C. H. Bird records the fact that a Green-backed Gallinule (*Porphyrio smaragdonotus*) was seen at Horsey by three different marshmen, one of whom recognised the bird from having seen a locally killed specimen some years previously.

Solitary Sandpiper in Kent.

The Duchess of Bedford, in "British Birds" for September, gives a most interesting account of a Solitary Sandpiper (*Totanus solitarius*) which she had the good fortune to watch at close quarters when on the coast of Kent in July last. At first, supposing it to be a Green Sandpiper, and desiring to make absolutely certain of this, the bird was put up in order that the identification mark of the species—the white rump—might be exposed. As this did not appear, the bird was again stalked and carefully surveyed at close quarters, when it became certain that the bird was really a specimen of the Solitary Sandpiper. A second specimen

was also seen, but this was before the identity of the species had been determined.

By way of confirming Her Grace in this observation it is interesting to note that a specimen of this bird was shot at Littlestone on August 15.

Golden Oriole in Fifeshire.

A female *Oriolus galbula* is reported in the Annals of Scottish Natural History as having been obtained on Markinch on May 13, 1908.

Woodchat Shrike in Sussex.

The *Zoologist* for August contains a record of the fact that a male Woodchat Shrike (*Lanino pemeranus*) was shot near Rye on September 15, 1907.

Snowy Owl in Outer Hebrides.

Mr. I. A. Harvie Brown, in the Annals and Magazine of Natural History, records that a fine example of the Snowy Owl was shot in South Uist in October, 1907.

Common Bittern in Haddingtonshire.

The Rev. H. Bonar, in the Annals of Scottish Natural History, records the fact that a Bittern was picked up dead on Gullane Links in April of this year. This makes the third record of the Bittern in East Lothian for 1908.

Pallas's Sand Grouse in Essex, Kent, and Yorkshire.

The *Field*, September 12, records the fact that on September 1 a Sand-Grouse (*Syrrhaptes paradoxus*) was shot at Great Mollands Farm, South Oxenden, Essex, but no record is given as to the sex of this bird, or whether others were seen.

"British Birds" for September contains a note by Mr. T. H. Nelson to the effect that during the first week in June three Sand Grouse were seen in a field of young corn in the eastern portion of Cleveland. Soon after one was picked up dead—a male in perfect plumage. The other two birds were seen at intervals during June, when they disappeared.

Three were seen in Kent on July 4 on the sandhills at Littlestone by Mr. A. G. Alexander.

PHYSICS.

By Professor A. W. Porter, B.Sc.

The Streamers in the Electric Spark.

The work of Schuster and Heinsalech on the streamers in an "inductionless spark" has recently been extended by Dr. S. R. Milner to those in an "inductive spark." The observations were taken by photographing the spectrum as drawn out by a rotating mirror, the slit of the spectroscope being removed and replaced by the spark itself, so that each line in the spetcrum formed a monochromatic image of the spark. To prevent overlapping, the prisms in the spectroscope were so arranged that while the images of the spark were vertical and drawn out in a horizontal direction the dispersion of the spectrum was in a direction of 45° to the horizontal. The following conclusions were arrived at:—

(1) The streamers in the inductive spark consist of metallic vapour, the atoms of which are charged, and the motion of the vapour toward the centre of the spark gap is mainly due to the action of the electric force of the spark upon the charged atoms.

(2) The different lines of the same metal give streamers of different character: (*a*) blurred streamers which are given by lines prominent in the arc; (*b*) sharply defined streamers given by pure spark lines which are never present in the arc; (*c*) a third class is very bright during the first oscillation, but fade away very rapidly. These are very sensitive to inductance, disappearing altogether from the condensed spark when a moderate inductance is present. The differences between these three classes is due solely to the duration of the luminosities of the metallic lines to which they correspond, the arc lines having a long, the spark lines a short, and the "condensed spark" lines a very short duration.

The photographs obtained show that the velocities of the streamers corresponding to the different lines in the same spark are the same in spite of the different character of the streamers.

The Number of Alpha Particles from Radioactive Substances.

Professor Rutherford has recently applied two methods for determining the number of alpha particles which are emitted per second from different radioactive substances.

The first method is an electrical one, and makes use of the fact discovered by Townsend that in a sufficiently great electrical field the small current through a gas, owing to an external ionising agency, may be easily increased many hundreds of times as a result of a production of fresh ions by collision.

This magnification of effect enables the production of even a single alpha particle to be observed. The detecting vessel was a brass cylinder with a central wire insulated from it by passing through ebonite corks. The central wire was connected with one pair of quadrants of a Dolezalek electrometer, and the outside tube to the negative terminal of a large battery of small accumulators the other pole of which was earthed. The tube was partially evacuated. The alpha particles entered from another vessel through a glass tube penetrating one of the ebonite corks and having its end covered by a thin plate of mica, through which the particles were fired.

With this arrangement the entrance of each alpha particle caused a small throw of the needle of the electrometer, and the counting of these throws during a given interval gives at once the number of particles entering the tube. Of the total number of particles given off from the radioactive substances employed only a very small fraction will enter the tube, since (as was carefully verified) the emission takes place equally in all directions. The conclusion come to is that, on the average, 3.4×10^{10} alpha particles are expelled per second from the radium C present in one gramme of radium in equilibrium. From the experiments of Bragg and the measurements by Boltwood of the ionisation due to the alpha particles from each of the products of radium, it appears certain that the same number of alpha particles are expelled per second from radium itself and from each of its α-ray products in equilibrium with it. It follows that from one gramme of radium, together with its equilibrium products, 13.6×10^{10} alpha particles must be emitted per second.

The second method is an optical one. Assuming that each scintillation of a screen of zinc sulphide in a spintharioscope is due to the impact of an alpha particle, the enumeration can be made directly. The result comes out within a few per cent. of the number obtained by the previous method.

These results are consistent with the assumption that the charge on an alpha particle is double the electronic charge, and that this particle is a helium atom.

ZOOLOGY.

By R. Lydekker.

The British Hares.

It is somewhat sad to reflect that even the natural history of the British Isles is being "made in Germany," or at all events by German writers. An eminent German naturalist is, for instance, largely responsible for the splitting process which has been recently applied to many of our birds; while it has been left to another German, Dr. Max Hilzheimer, to decide that we possess three species of indigenous hares in place of two. The common brown hare (now known as *Lepus europœus*) remains, of course, *in statu quo;* but, according to our author, the Scottish and the Irish blue hares should be regarded as distinct species, the former under the name of *L. medius*, and the latter as *L. timidus*. The Scottish hare, which is specifically identical with one inhabiting Zealand and Central Russia, is regarded, indeed, as to some extent intermediate between the brown hare and the Irish blue hare, of which the last forms a local race of the typical Scandinavian *L. timidus*. In the Scottish species the ears are, for instance, rather larger than in the Irish hare, while the upper surface of the tail is at all seasons black in place of white. Whether such differences are really of specific value must be to a great extent a matter of individual opinion.

XUM

Cave-Dwelling Snakes.

Up to a comparatively recent date no reptiles were known to have adapted themselves to an existence in the darkness of caverns. About 1898 it was, however, discovered that considerable numbers of a well-known eastern Asiatic species of *Coluber* frequent certain caves in the Selangor district of the Malay Peninsula, where they feed exclusively on the bats by which the cave is mainly tenanted. These snakes attain a length of between eight and nine feet, and by comparison with their out-of-door relatives it has been found that the cave-haunting individuals are much paler-coloured than ordinary. Moreover, the colouring of these snakes presents a remarkable resemblance to that of the rocks forming the walls of the cave; thus, at first sight, suggesting that the reptiles are very ancient cavern-dwellers. Of course, such a protective resemblance would be of no use to them when in the pitchy darkness of the innermost parts of the cave, but many of these snakes are in the habit of taking up their quarters on ledges near the cave's entrance, from which coigns of vantage they seize the unfortunate bats as the latter pass in and out. The cave-walls consist of yellowish crystalline limestone traversed by occasional blackish veins generally running in a more or less nearly vertical direction. With these rocks the colours and markings of the snake harmonise in a most remarkable manner, a blackish line which runs along each side of the reptile's tail simulating the black veins in the rock. In reference to the suggestion that the snakes are ancient inhabitants of the cave it should be mentioned that young specimens have not apparently been found within the cavern; and, if it really be that the species breeds only in the open, the resemblance in colouring must be due solely to fading in each individual case, some support being afforded to this view by the fact that the black tail-line is present in all instances.

This snake is known as *Coluber tæniurus*. Quite recently it has been discovered (as reported by Mr. G. A. Boulenger) that an allied member of the same genus—*Coluber moellendorffi*—is likewise in the habit of taking up its quarters in a cavern of Stygian darkness in Tonkin. In this case, although the cavern is also of limestone, the colouring is of quite a different type from that of the Malay species, the upper-parts of the creature's body being grey with dark spots and the tail ringed with red and black. Hence it has been argued that the resemblance of the Malay species to its surroundings is purely accidental—any design on the part of the Creator of the Universe being, as usual, ignored.

Cannibal and Spitting Snakes.

While on the subject of snakes I may take the opportunity of referring to correspondence which has recently taken place with regard to the cannibalistic and venom-spitting propensities of certain species. It is well known that the king-cobra of South-Eastern Asia, which occasionally reaches a length of fully 15 feet, is in the habit of preying on non-venomous serpents of other species. An individual specimen of this snake, measuring a little over 11 feet in length, has, however, been seen in Burma carrying another member of its own species in its jaws, much as a terrier carries a rat; while on a second occasion a king-cobra was observed in the act of eating an ordinary cobra, and in a third case a cobra had been actually swallowed. Another king-cobra has been known to devour the banded crait; while from the stomach of yet another specimen was taken an example of the still more venomous Russell's viper. At first sight these instances suggest that the devourer must be immune to the venom of the devoured; but, according to experts, such conclusions are not justified by the present state of our information with regard to the action of serpent-poison.

Several venomous African snakes have been long known to be in the habit of spitting out their venom when molested, and to the list must now be added the Gaboon viper, or river-jack viper (*Bitis gabonica*), which has been observed to eject its secretion to a considerable distance. One drop ejected into the human eye will cause severe temporary pain or even permanent injury; while dogs are completely blinded when thus struck.

REVIEWS OF BOOKS.

ASTRONOMY.

The Study of Stellar Evolution. An Account of some Recent Methods of Astrophysical Research, by George E. Hale. Chicago: Decennial Publications, second series, Volume X. (London: Wesley and Son, 1908; pp. xi. and 252, with 104 plates; 16s. 6d.).—To many people keenly interested in science some of its "leading lights" are names and nothing more. But this cannot be said of large numbers of British amateur and professional astronomers in the case of Professor Hale, who is to them an extremely vivid personality. Comparatively a young man, he holds a commanding position, and his clear thinking and command of language and ideas will not readily be forgotten by those who heard his address on opportunities for astronomical research with comparatively simple and inexpensive apparatus—a very wholesome tonic to those who were inclined to fear their occupation would be gone or rendered useless by the increasing strength of the "big battalions" arrayed in great modern observatories, such as that at Mount Wilson, of which Professor Hale is director. A chapter on the subject of that address is incorporated in the present volume, which was originally intended as a handbook to Yerkes Observatory. It is refreshing to find that the author frankly acknowledges greater attention and concentration on phases of the work that specially appealed to him and with which he had more immediate practical concern. This means, of course, that he has not attempted to dogmatise generally on all points, which is a plan that can be strongly recommended. But it must not be inferred that much is missing in the book, as Professor Hale's activities are manifold. He explains, as his title implies, how the life histories of sun and stars are investigated since the introduction of spectroscopic methods has revolutionised the scope of an observatory into the likeness of a physical laboratory. A brief historical sketch is followed by several chapters on the sun, the only star near enough for detailed study, including the wonderful advances made by the aid of the spectroheliograph, with which the author's name is so intimately associated, both at Yerkes and at Mount Wilson, which may be taken as types of the older and newer models of observatories, and of both of which Professor Hale writes from intimate knowledge. Stars in general are reached by way of sun-spots and red stars, the relation between them being paralleled by laboratory experiments. The Nebular Hypothesis follows naturally, and the Meteoritic and Planetesimal, which have in turn been proposed as alternatives. Much is expected from the new 5-foot reflector at Mount Wilson, much of the work on which has been done at the observatory workshops at Pasadena, and is described by Professor Hale, who has found this work of great interest to visitors. Possibilities of new work and new instruments and the substance of the address already indicated complete the volume, which contains no less than 104 half-tone plates. If exception be taken to anything it will probably be to the actual weight of the volume, which is of the heavy paper apparently popular with some American publishers.

BIOGRAPHY.

Giordano Bruno, by Dr. Alois Riehl, translated by Agnes Fry (Edinburgh: T. N. Foulis, 1907; 2s. 6d. net).—All lovers of science will appreciate this translation of a masterly essay. The life, and work, and death of this pioneer of science stand out here sharply defined in the author's and translator's terse phrases. No better idea can be obtained of the man than these few pages present.

Gilbert White of Selborne, by W. H. Mullens, M.A., LL.M. (London: Witherby and Co., 1908; 32 pp. and 7 plates; 2s. 6d. net).—This little work contains the material of a lecture delivered by the author before the Hastings and St. Leonards Natural History Society, and is in a concise form practically the sum and substance of all that most readers of White's famous work need to know in order to fully appreciate his work. The family history is dealt with, the ornithology of the book, the various ideas which caused

White to become his own author, and a useful bibliography of the older editions is given. Perhaps justice is scarcely done to that side of the naturalist which dealt with other forms of natural history than that of ornithology. The plates are admirable, and include one of the entries in the Parish Register of White's birth and death. We fear that the moss and lichen must have been cleared off the tombstone in the churchyard in order to take the photograph, which appears as one of the plates, and this may be regretted by some people. The work is a valuable addition to our Gilbert White bookshelf, and will deserve a more permanent binding.

CHEMISTRY.

A Text-book of Organic Chemistry, by Professor A. F. Hollemann. Translated from the Dutch by A. J. Walker, Ph.D., B.A., and O. E. Mott, Ph.D., pp. xvii. and 555 (London: Chapman and Hall, 1907; 10s. 6d.).—As a text-book this is admirable, and the author is fully justified in his attempt to avoid the congestion of isolated facts found in many elementary works on organic chemistry. There can be no doubt that the student gains in his grasp of the subject by the method of selecting typical substances and studying these in detail instead of giving long lists of names which only tend to confusion. The methods by which the constitution of organic compounds is determined is fully and clearly described, and the close relationship between physics and modern chemistry is well brought out. The importance of organic chemistry in manufacturing processes is also touched upon, and brief descriptions of certain manufactures are given. In this connection it may be mentioned that a time-honoured error has duly found its place in the description of the making of vinegar, where it is stated that the bacteria act best at a temperature of 95° F. It is within the present writer's experience that in this country, at all events, vinegar bacteria work best at a temperature of 110° F., which is several degrees above their thermal death point, according to the Continental text-books. Another slight error occurs on p. 109, where it is stated that stearic and palmitic acids are the principal constituents of animal and vegetable fats. This is not true of all animal fats, whilst in most vegetable fats the chief constituents are oleic acid and similar liquid fatty acids. But such errors are trifling and do not detract from the general excellence of the work. The book is well translated, and the printing leaves nothing to be desired. Some simplication of the index, however, would be a great improvement in the next edition.

MISCELLANEOUS.

The Destruction of Daylight; A Study in the Smoke Problem, by John W. Graham, M.A. (London: George Allen, 1907; pp. 152; 2s. 6d. net).—The author does not aspire to teach anything to the smoke expert, but rather addresses himself to the ordinary manufacturer and to the citizen, as it lies with them to abate the smoke nuisance. After pointing out the value of sunlight, the author proceeds to show how the air is vitiated by smoke, and so loses much of its health-giving powers. The following extract shows the seriousness of the subject:—

The Hon. Rollo Russell has made a calculation of the actual cost of smoke and fog to London each year; he took as a basis the one million houses and works of 1888, a number which has enormously increased since then. He puts down:—

Waste of fuel, estimated at one-fourth ...	£1,000,000
Extra washing, and wear and tear of linen, etc.	£2,150,000
Dresses, curtains, carpets, blinds, and other textile fabrics damaged and renewed	£1,000,000
Increased mortality (valued on its economic side only), impairment of health, illness, and consequent expenses, reduced strength, hindered convalescence, lower vitality, and working capacity	£320,000
Total ...	£4,470,000

He then puts down a million for the following numerous miscellaneous losses:—"Slow destruction of stonework (*e.g.*, Westminster Abbey), granite, marble, etc., on public and private buildings, and cost of cleaning exteriors; destruction of mortar, cement, etc., making re-painting necessary (see Angus Smith on 'Air and Rain'); painting of houses inside and outside; restoring gilding, metal work, shop fronts, signs, names of streets, advertisements; restoring monuments, etc. (*e.g.*, Albert Memorial and drinking fountain in Great George Street); window cleaning, skylight cleaning, etc., including station roofs, replacement of blackened wall-papers, etc., depreciation or restoring of works of art, pictures, books, engravings, etc., in public and private collections; loss of time by artists, photographers, and other workers requiring daylight; extra labour owing to tarnishing of silver, etc.; damage to trees, plants, flowers, vegetables, fruit, in or near London; loss of time by delay of trains, etc., accidents of all sorts, cost of fog signals, supervision of river traffic; extra gas, extra candles and lamps, both in dark fogs and in shortened morning and evening light throughout the year; extra fuel burnt owing to want of sunshine and loss of warmth; cost of chimney sweeping, cowls, light reflectors; absence from London of many of its richer citizens, and depreciation of house property." This category of losses has excited the attention of the Commissioners of Works, who have addressed a memorandum to Parliament on it.

The total comes to £5,470,000, which represents about £1 per head, and is not far from the cost of the coal used in London houses. It is impossible to remember many figures, but it may be easy for the reader to recollect that the smoke costs nearly as much as the coal. John Bright is reported to have said that a sunny day was worth a million sterling to England. This estimate of solar energy may be more oratorical than mathematical; but the value must be very large.

With the view of mitigating the large amount of smoke issued into the air, the author says that there seems little reason why many of us should not burn coke. Gas stoves are also convenient. He also mentions some grates which stood three series of long and careful tests, instituted by the Coal Smoke Abatement Society. Much of the smoke emitted from boiler and furnace fires of factories might be obviated if greater attention were given to proper stoking. The author concludes by saying: "We would fain persuade the better-minded mill owners that to make smoke is disgraceful, inconsistent with self-respect and good-will, and we want a public opinion determined to coerce the careless and selfish ones with an effective law."

A Bibliograph of the Works of Sir Isaac Newton, by George J. Gray (Cambridge: Bowes and Bowes, 1908; 5s. net).—This is a reprint of a limited edition published in 1888. Many important additions have been made, and it now consists of eighty pages. It includes a list of books illustrating Newton's works. The frontispiece is an excellent reproduction of the statue in the ante-chapel of Trinity College.

A NEW X-RAY PLATE.—Messrs. Wratten and Wainwright have recently introduced a new X-ray plate, the outcome of exhaustive experiment by Dr. C. E. Kenneth Mees, of that firm. X-ray plates are usually coated with a thick film of silver salts, but in the one under notice the makers have added a second metal to the emulsion which has the property of stopping the rays and transferring them by secondary radiation to the neighbouring silver particles, as well as greatly reducing the amount of the secondary radiation itself—points of considerable bearing on the result of the exposure. The precipitate of the added metal is removed to a great extent in the hypo fixing bath, but there still remains after fixing an opalescence in the negative which does not in any way interfere with the visual examination or printing of it. Should it be desired, however, the precipitate can be completely removed by a bath of weak hydrochloric acid during washing. The plates are sent out, each satisfactorily packed in black paper, which will be much appreciated by radiographers. We have tested and compared these plates with those of all the well-known makers, and are of opinion that they are, for speed, density, contrast, and definition, the best for radiographic work.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Preparation of Microscopical Objects.

(*Continued from page 220.*)

The preceding papers of this series have been devoted to the principles underlying the fixing, hardening, dehydrating, and clearing of material, and to the means by which thin sections may be best prepared, each step being of the utmost importance and requiring careful performance if the object is to be efficiently studied. We have now, however, to deal with a most important branch of our subject, namely, the staining of objects, whether general or differential, in order that their structure may be made more evident. The staining which merely colours a section, or portions of a section, so as to make a pretty picture of it, is of little importance; what is of great importance is that staining which comes as an aid to the worker by enabling him to differentiate out the structures he is endeavouring to study, independently of the resolving power of his lens. It is scarcely necessary to insist upon the importance of the matter, and there is no doubt that much of our advance in microscopical discovery depends on the elaboration of existing staining methods, and the discovery of new ones. At the same time we are now-a-days, perhaps, apt to depend too much on the colouring of structures and to neglect careful microscopical examination.

Though much remains to be done, so much has already been accomplished that it is quite impossible for me to attempt in these columns to describe methods of staining applicable to individual cases. Histology, pathology, bacteriology, clinical methods, zoology, and botany all have volumes devoted to their special and individual requirements, and I can only endeavour here to give a general outline of the broad principles which underlie staining methods and to leave their application to my readers.

Of course, an efficient stain necessitates a chemical combination between some of its constituents and the section to be stained, but, unfortunately, a chemical classification is impossible in the present state of our knowledge, and any attempt at it would be highly technical and of little value to the ordinary worker. I think, therefore, I shall content myself with merely pointing out that a stain may be a *general* stain, that is, it will stain the whole section more or less uniformly of one colour, or it may be a *specific* stain, which means that it has a special affinity for a certain kind or kinds of structure, and that it stains these more than, or to the exclusion of, other structures in the same section. The value of the latter type of stain is obvious.

There are, moreover, two ways of using such *specific* stains. There is the *progressive* method which selects a suitable specific stain and allows this stain to act until the special structure which it is desired to observe is sufficiently deeply stained to differentiate it from the surrounding structures (which may or may not be themselves stained by the same re-agent in a less degree), and there is the *regressive* method which deliberately overstains, with a view to extracting some of the colour afterwards, leaving the special structures more deeply stained than the others. It may be observed in passing that this "backward" method is the most generally useful, and is the means by which some of our most useful work has been done.

I have before called attention to the great importance of properly "fixing" an object as one of the first of the necessary steps in its preparation, and I may now add that objects which are not fixed generally stain in an unsatisfactory manner, whilst objects which are still living practically do not take a stain at all. An exception to this is found, however, in certain stains which are used in very dilute form to stain faintly cells which are still living. But, as a matter of general practice, all objects must be properly fixed when fresh, and then hardened. Most objects will also be dehydrated, but it is worth noting that the general idea that microscopical material can be kept indefinitely in alcohol until required has qualifications, as long preservation in alcohol frequently militates against subsequent methods of staining.

There are still one or two other considerations. Objects can be stained in bulk before section cutting, or the sections can be stained after cutting, either loose or affixed to a slide or a cover-glass as already explained in detail. The staining in bulk is generally used for *general* staining only, whilst *specific* staining is generally confined to sections, and may then be either progressive or regressive, as mentioned above.

Again, most stains are dissolved in one of two media —either alcohol or water. This is an important distinction, as sections which have been carefully dehydrated would naturally be stained for choice in an alcoholic stain, whilst sections containing water would be most conveniently stained with an aqueous solution. Of course, dehydration or its converse can be carried out previously or subsequently as required, but not infrequently the choice of a stain will depend upon such considerations, or *vice versâ*. Very strong alcoholic solutions of stains are, however, not often used, the final dehydration being completed after staining.

In some cases stains require to be fixed by what are known to calico printers, etc., as "mordants," and this may be a deliberate part of the process, and, therefore, of practical importance, or it may be inherent in the method and of more theoretical interest.

Some writers on the subject of staining make classifications such as histological stains and cytological stains, nuclear stains, plasma stains, etc., but I think we may with advantage leave these distinctions to text-books dealing with special methods. It is, however, of distinct advantage to realise at an early stage that certain stains have a peculiar affinity for nuclear substance—a special action upon the "nuclei" of cells—whilst others have an equal affinity for the other elements of cells known as the "plasma."

The chemistry of the subject I shall dismiss very shortly, accepting the general classification into "basic," "acid," and "neutral" stains. This does not mean that the stains themselves are acid, basic, or neutral; it means that of the chemical components of the stain that part which stains would be, if isolated by chemical means, acid, basic, or neutral, as the case may be. The importance of the distinction to the ordinary worker lies in the fact that "acid" stains do not wash out in acids, but are made deeper by them; whilst "basic" stains are intensified by alkalies, and that acid stains are generally more soluble in water than in alcohol, and basic stains more soluble in alcohol. Neutral stains are also more soluble in alcohol.

(*To be continued.*)

Human Blood and Some Observations Upon Staining It.

For some time past a number of mounted preparations of stained blood films have passed through my hands, and in many instances I have been surprised at the very poor appearance presented both as regards the quality of their staining and also their preservation, the former being indistinct and far from sharp, while with regard to the preservation of the corpuscles, they have presented many forms and appearances far from their normal, being much shrunken, having very irregular periphery, and often grouped together in quite unrecognisable masses.

Perhaps the following few hints and records of my experience in treating blood films may be of some interest.

The blood is conveniently taken from a puncture made in the lobe of the ear previously sterilised.

The film should be made by allowing a small drop of blood to come in contact with a sterile cover slip (the thinnest should be used) near to its edge. The droplet is then touched with the edge of a cigarette paper and drawn with one direct sweep across the cover-glass.

Prepare two or three films in this way, let them dry quickly in the air and drop them film upwards into absolute alcohol or, perhaps better, equal parts of absolute alcohol and ether, for ten to fifteen minutes; remove and dry in a warm oven at 40° C.

They are then ready to receive the different staining processes.

In order to bring out sharply and well defined the nuclei alone of the Polynuclear leucocytes, proceed as follows :—

Float the cover-glass film downwards on the surface of Löffler's methylene blue for five minutes, wash rapidly in two changes of methylated spirit, dry thoroughly in a warm oven, and mount in Canada Balsam without any previous cleaning in an essential oil.

This will give a splendid exhibition of the minutest details of the nuclei alone in the case of the Polynuclear leucocytes, and a fairly good staining of both protoplasm and nuclei in the large and small Lymphocytes.

I have found rather more difficulty in obtaining good results in combined nuclear and plasma staining; one or other generally suffers from want of clearness and sharp definition. I would here mention that I see no advantage in staining first nucleus and then plasma by using separate solutions, except in the case of non-mammalian blood, when I do give preference to this method for the nucleated corpuscles.

I have obtained some of my best results by staining nuclei and plasma in one bath in the following manner :—

(*a*) Dissolve five grains of water-soluble eosin in half an ounce of distilled water and add half an ounce of rectified alcohol.

(*b*) Dissolve five grains of methyl green in one ounce of distilled water, mix *A* and *B* together while continually stirring, add eight drops of acid carbolic. Allow to stand for about an hour and filter.

Immerse the prepared films in the above for about five or ten minutes, wash thoroughly and quickly in distilled water, dry in oven, and mount in Canada Balsam without previous cleaning.

In this manner excellent results will be obtained in the case of the eosinophile cells and red corpuscles, good staining of nucleus and plasma in the Polynuclear leucocytes, but less good results with the large and small lymphocytes and mononuclear elements.

These remarks apply to the treatment of blood taken under pathological conditions as well as in the normal condition.

Finally, I strongly recommend that in order to obtain the best results all handling of the slips should be done with a clean pair of plated forceps and that the fingers should not come in contact with them even though they be quite clean.

There are, of course, various and numerous methods of preparing and fixing wet and dry films, but the above, if carried out with care, will afford many beautiful, interesting, and instructive slides, which will bear critical observation with the highest powers

E. J. S.

Microscopical Material.

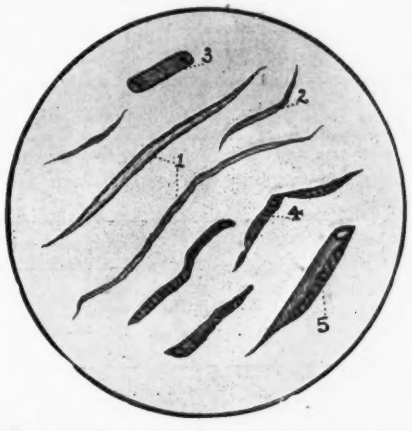
By the kindness of a correspondent I have received some wood cellulose from Aspen, accompanied by the following note and illustration :—

The Aspen (*Populus tremuloides*) is much used in America, and to a less extent on the Continent, in the manufacture of wood cellulose for paper manufacture.

The present specimen is quite typical, and under the microscope exhibits various cell structures including the following :—

1. True wood fibres which are flat with tapering ends and devoid of discord markings or pitting. The maximum length of these fibres is a little over 2mm.
2. Much shorter fibres similar to 1.
3. Short tubular cells, untapering.

4 and 5. Tapered cells which are much broader than the true wood fibres, and are pitted or marked superficially in characteristic fashion.



The pitted cells, which form only a small proportion of the cellulose vessels, are very beautiful objects under a high power—say $\frac{1}{6}$ inch objective. Chlor-zinc-iodine solution is the most suitable stain for temporary examination, but permanent mounts may be prepared with aniline stains and a glycerine medium. Aspen cellulose resembles very closely that prepared from poplar (*Populus grandidentata*) and from cottonwood (*Populus monilifera*).

I shall be glad to send some of this material to those who care to apply for it. Applications must be accompanied by a stamped and addressed envelope and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for October.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.2 and sets at 5.38; on the 31st he rises at 6.53 and sets at 4.34.

Sunspots and faculæ have been unusually conspicuous of late, especially as the sunspot maximum occurred three years ago. At the time of writing two large groups are on the disappearing limb of the disc, and as these groups have already survived one rotation and are still of large area, there appears to be every probability that they will again be available for observation during the early part of the month. The granular structure of the surface can be particularly well seen on foggy mornings, as the atmosphere is quiet and the image steady.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Oct. 2 ..	26° 13′E	6° 36′	329° 12′
,, 7	26° 25′E	6° 19′	263° 14′
,, 12 ..	26° 26′E	5° 59′	197° 16′
,, 17 ..	26° 16′E	5° 37′	131° 19′
,, 22 ..	25° 54′E	5° 11′	65° 22′
,, 27 ..	25° 21′E	4° 44′	359° 26′
Nov. 1 ..	24° 36′E	4° 14′	293° 30′

THE MOON:—

Date.	Phases.	H. M.
Oct. 3 ..	☽ First Quarter	6 14 a.m.
,, 9 ..	○ Full Moon	9 3 p.m.
,, 17 ..	☾ Last Quarter	3 35 a.m.
,, 25 ..	● New Moon	6 47 a.m.
Oct. 8 ..	Perigee	3 54 a.m.
,, 20 ..	Apogee	2 6 a.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible from Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Oct. 11	B.D. + 12° 436 ..	5·9	10·46	73°	11 53	231°
,, 29	9 Sagittarii	5·7	6·19	37°	7·0	323°
,, 30	B.A.C. 6490	5·7	5·28	45°	6·26	305°

THE PLANETS.—Mercury (Oct. 1, R.A. 14h 0m; Dec. S. 14° 56′. Oct. 31, R.A. 13h 57m; Dec. S. 11° 45′) is an evening star in Virgo and Libra. The planet is at greatest easterly elongation of 25° 33′ on the 4th, when he sets at 5.59 p.m. or only 28 minutes after the sun, thus the elongation is not a favourable one. The planet is in inferior conjunction to the sun on the 28th.

Venus (Oct. 1, R.A. 9h 39m; Dec. N. 13° 20′. Oct. 31, R.A. 11h 49m; Dec. N. 2° 38′) is a morning star in Leo, rising at 1.46 a.m. on the 1st and at 2.54 a.m. on the 31st or about 4 hours before the Sun. The apparent diameter of the planet on the 15th is 18″ whilst ·65 of the disc is illuminated, thus she is a brilliant object in the morning sky. On the morning of the 14th at 4 a.m. there will be an interesting conjunction of the planet with Jupiter, the separation being only 36′ with Venus to the south. The planets may thus be seen in the same field of view of the telescope and an interesting comparison of their colours made.

Diagram showing Conjunction of Venus and Jupiter.

Jupiter (Oct. 1, R.A. 10h 25m; Dec. N. 10° 52′) Oct. 31, R.A. 10h 45m; Dec. N. 8° 57′) is a bright object in the morning sky and is situated in Leo. At the beginning of the month the planet is visible for about three hours before sunrise and for more than five hours towards the end of the month. The planet is in conjunction with Venus on the 14th, see above.

Saturn (Oct. 1, R.A. 0h 29′; Dec. N. 0° 11′. Oct. 31, R.A. 0h 21m; Dec. S. 0° 38′) is very favourably placed for observation, being due South on the 15th at 10.48 p.m. The planet is the most conspicuous object in the sky looking South about 10 p.m., when he may be observed shining as a bright star without scintillation, but with a peculiar lustre which has given it the name of the leaden planet. The outer major and minor axes of the ring system are respectively 45″ and 4″·5, so that the ring is slightly open; the diameter of the ball is 18″. On the morning of the 9th the planet appears 2° North of the Moon at 3 a.m. In a good 3-inch telescope the ring is visible with a power of about 50 and the belts on the planet's surface with a power of about 80.

Uranus (Oct. 15, R.A. 18h 57m; Dec. S. 23° 13′) remains in Sagittarius, but is not very favourably situated for observation, being low down and setting soon after 10 p.m. at the beginning of the month, and at 8 p.m. at the end of the month. The planet is situated about 2° S. of the star ξ² Sagittarii.

Neptune (Oct. 15, R.A. 7h 14m; Dec. N. 21° 35′) rises shortly after 9.30 p.m. and crosses the meridian at 5.40 a.m. at the middle of the month. The planet is situated about half a degree South of the star δ Geminorum, is in quadrature on the 6th and stationary on the 20th.

METEORS.—The principal meteor shower during the month is that having its radiant point near ν Orionis, and hence known as the Orionids. The maximum is from the 18th to the 20th, and the meteors are described as swift with streaks. The radiant point is in R.A. 6h 8m, Dec. N. 15°.

Mira (ο Ceti) is due at maximum on the 11th, and observations should be made about this time to determine its maximum magnitude. Observations of its spectrum containing bright lines will also be of interest.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—γ Arietis 1h 48m, N. 18° 48′, mags. 4·2, 4·4; separation, 8″·8. Easy double, power 30; notable as being the first double star observed telescopically.

γ Andromedæ 1h 58m, N. 41° 51′, mags. 2·1, 4·9; separation 10″·2. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a binary, the components of which are now less than 1″ apart.

NEBULÆ.—Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedæ. Seen with a three or four inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.